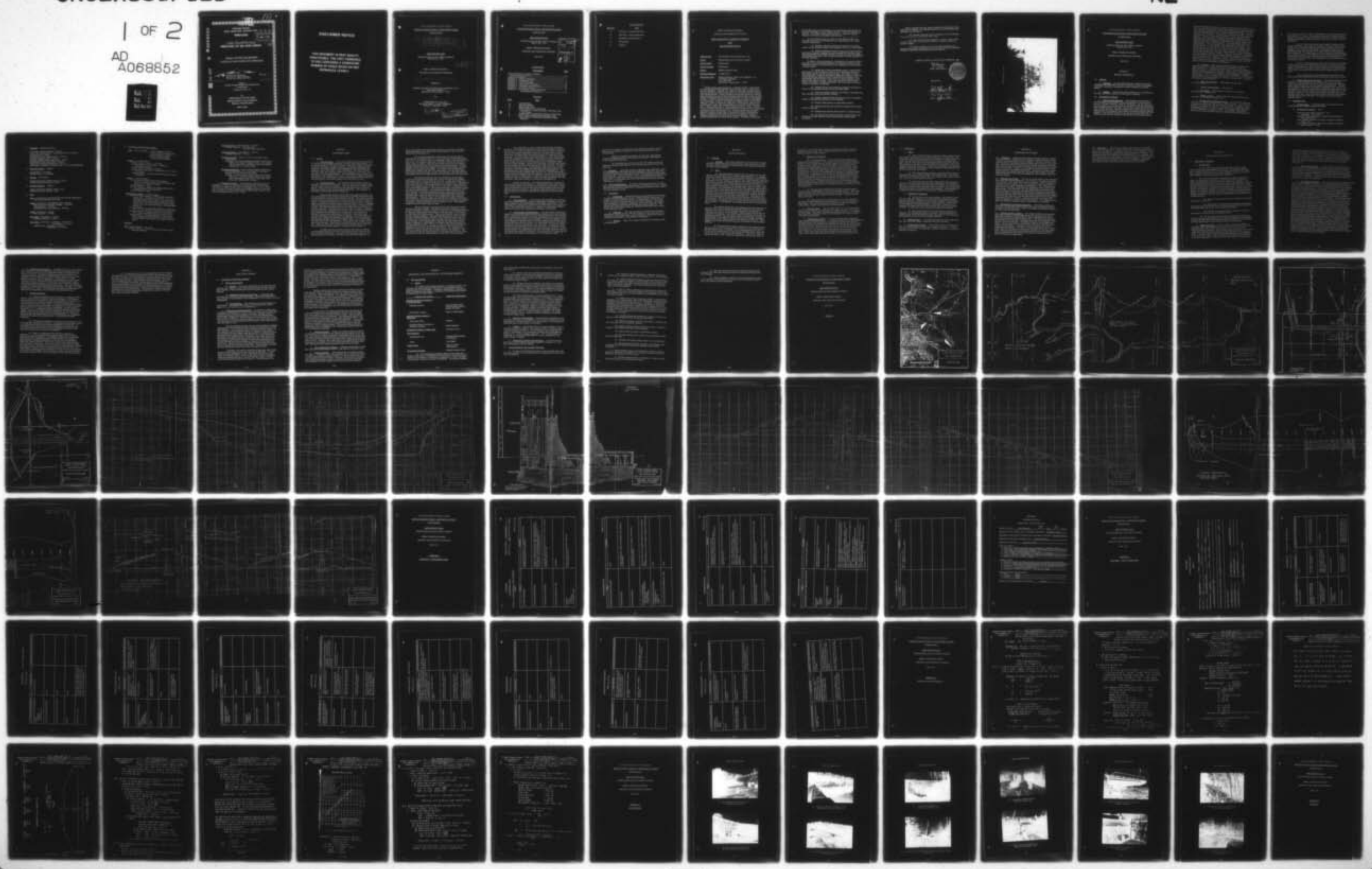
AD-A068 852 GANNETT FLEMING CORDDRY AND CARPENTER INC HARRISBURG PA F/G 13/2
NATIONAL DAM INSPECTION PROGRAM. LAKE SCRANTON DAM (NDS ID 374)--ETC(U)
MAY 78 DACW31-78-C-0046

UNCLASSIFIED NL

1 OF 2

AD
A068852



SUSQUEHANNA RIVER BASIN

STAFFORD MEADOW BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Distribution Unlimited
Approved for Public Release
Contract No. DACW31-78-C-0046

Prepared by
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

MAY 1978

DISCLAIMER NOTICE

SUSQUEHANNA RIVER BASIN

STAFFORD MEADOW BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

6

National Dam Inspection Program.
Lake Scranton Dam (NDS ID 374),
Susquehanna River Basin, Stafford Meadow
Brook, Lackawanna County, Pennsylvania.
Phase I Inspection Report.

LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY
(NDS ID No. 374)

12 98p.

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

15 DACW31-78-C-0046

Prepared by

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105

For

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

11 MAY 1978

Gm

SUSQUEHANNA RIVER BASIN

STAFFORD MEADOW BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY
(NDS ID No. 374)

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1978

CONTENTS

PLATES

APPENDICES

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam: Lake Scranton Dam (NDS ID No. 374)

Owner: Pennsylvania Gas and Water Company

State Located: Pennsylvania

County Located: Lackawanna

Stream: Stafford Meadow Brook

Date of Inspection: 12 April 1978

Inspection Team: Gannett Fleming Corddry and Carpenter, Inc.
Consulting Engineers
P.O. Box 1963
Harrisburg, Pennsylvania 17105

ABSTRACT

Based on the visual inspection, available records, calculations and past operational performance, Lake Scranton Dam is judged to be in good condition. However, the spillway (main and auxiliary) will not pass the Probable Maximum Flood (PMF) or one-half of the PMF without overtopping the dam. If Lake Scranton Dam should fail due to overtopping, the hazard to loss of life downstream from the dam would be significantly increased from that which would exist just prior to overtopping the dam. Based on criteria established for these studies by the Department of the Army, Office of the Chief of Engineers (OCE), the spillway capacity is rated as seriously inadequate. The existing spillway can accommodate a flood with a peak inflow of 28 percent of the PMF peak flow. Lake Scranton Dam is located upstream of No. 5 Dam. Failure of Lake Scranton Dam due to overtopping would probably cause overtopping and failure of this downstream dam. Williams Bridge Dam is located upstream of Lake Scranton Dam. Results of a Phase I Investigation Report on Williams Bridge Dam showed that the spillway capacity of Williams Bridge Dam was rated as seriously inadequate, based on criteria established by OCE for these studies. If Williams Bridge Dam

Cont

should fail because of overtopping, the overtopping potential and the potential for failure of Lake Scranton and No. 5 Dams are greatly increased. The safety of Lake Scranton Dam is, therefore, directly affected by the safety of Williams Bridge Dam. ABSTRACT

In view of the concern for safety of Lake Scranton Dam, the following measures are recommended to be undertaken by the Owner as soon as practical:

(1) Develop a detailed emergency operation and warning system for the Williams Bridge, Lake Scranton, and No. 5 Dam system.

(2) Perform additional studies to more accurately ascertain the spillway capacity required for Lake Scranton Dam as well as the nature and extent of mitigation measures required to make the spillways hydraulically adequate. Also include provisions to repair concrete of the main spillway.

In order to correct operational, maintenance and repair deficiencies and to more accurately determine the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Install four or more observation wells, or other instrumentations, in the downstream slope of the embankment adjacent to the masonry gravity section of the main dam. Two wells, or other instrumentation, should be installed at different elevations to the left of the embankment retaining wall to determine the condition of the embankment near the location where water is being collected by the gravel drain behind the wall. The others should be located at the Owner's discretion. Monitor instruments and record data so that any change in condition is detected.

(2) Visually monitor the quantity of seepage that exists at the toe of the embankment near the gravel-filled sump.

(3) Study the possible benefits of providing a floating trash boom upstream from the auxiliary spillway.

(4) Replace missing riprap and remove shrubs on upstream surface of embankment adjacent to main spillway.

(5) Remove trees growing on downstream surface.

(6) Provide anchorage and shelter for propane tank located at toe of main dam.

(7) Maintain and operate gated outlets on a regular basis.

(8) Visually monitor leakage quantity on downstream face of masonry gravity section of main dam and make repairs when necessary.

Before remedial work that corrects hydraulic deficiencies in the spillways is complete, the following measures are recommended to be undertaken by the Owner:

(1) Provide round-the-clock surveillance of Lake Scranton Dam during periods of unusually heavy rains.

(2) Have personnel and equipment available during floods to remove any debris that causes the main or auxiliary spillway to become clogged.

(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

GANNETT FLEMING CORDDRY AND CARPENTER, INC.

A. C. Hooke

A. C. HOOKE
Head, Dam Section

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
ALBERT CHARLES HOOKE
ENGINEER
No. 2201-E

APPROVED BY:

John H. Kenworthy

JOHN H. KENWORTHY
LTC, Corps of Engineers
Acting District Engineer

DATE: 6 June 1978

LAKE SCRANTON DAM

Lake Scranton Masonry Gravity Dam,
Auxiliary Spillway Arches,
Screen Chamber Building, and Gatehouses
Looking Upstream

SUSQUEHANNA RIVER BASIN

STAFFORD MEADOW BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY
(NDS ID No. 374)

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1978

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Lake Scranton Dam consists of two independent impoundment structures separated by high natural ground. The first structure, which is considered to be the main dam, is a combination of a masonry gravity dam and an earthfill embankment with a central masonry core wall. The masonry gravity dam is 60 feet high and 320 feet long. Arched openings were constructed through the upper portion of the masonry dam in order to provide auxiliary spillway capacity. The earthfill section of the dam is about 290 feet long. A sloping masonry gravity retaining wall projects downstream from the

left end of the masonry gravity dam to retain the adjacent earthfill and serve as a training wall for the auxiliary spillway. The second impoundment structure contains the 100-foot long main spillway and a 360-foot long earthfill embankment with a central masonry core wall. The main spillway is 20 feet high. It consists of a reinforced concrete ogee surface that was constructed atop the original masonry gravity stepped spillway. Masonry gravity retaining walls project downstream from both ends of the spillway to retain the adjacent earthfill and serve as training walls for the spillway. Embankment was placed against the upstream face of the gravity spillway. A roadway bridge spans the main spillway. The road crosses both impoundment structures and is continuous around the reservoir. There are two outlet works. One outlet works is located near the center of the masonry gravity section of the main dam and consists of a screen chamber, two gatehouses, one 36-inch supply line, and one 24-inch and one 36-inch emergency line for drawing down the reservoir. The other outlet works, primarily for water supply functions, is located along the shoreline of the reservoir, and consists of a building, known as the pavilion gatehouse, that contains screens, slide gates, pumps, and chlorination equipment. Various features of the dam are shown on the Plates at the end of the report and on the Photographs in Appendix D.

b. <u>Location</u>. The dam is located on Stafford Meadow Brook approximately 5-3/4 miles upstream of the confluence with the Lackawanna River. The dam is located 1-1/4 miles below Williams Bridge Dam and 2-1/4 miles above No. 5 Dam. Lake Scranton is shown mainly on USGS Quadrangle, Scranton, Pennsylvania, with coordinates N41°22'48" - E75°37'50" and partly on USGS Quadrangle, Olyphant, Pennsylvania, with coordinates N41°23'30" - E75°37'30" in Lackawanna County and is 2 miles southeast of Scranton, Pennsylvania. The location map is shown on Plate 1.

c. <u>Size Classification</u>. Intermediate (60 feet high, 8,442 acre-feet).

d. <u>Hazard Classification</u>. High hazard.

e. <u>Ownership</u>. Pennsylvania Gas and Water Company, Wilkes-Barre, Pennsylvania.

f. <u>Purpose of Dam</u>. Water supply for the metropolitan area of the City of Scranton, Pennsylvania.

g. <u>Design and Construction History</u>. Lake Scranton Dam was built for the Scranton Gas and Water Company in 1898. The design and construction supervision was performed by William M. Marple, Chief Engineer of Scranton Gas and Water Company, and by Alphonse Fteley, Consulting Engineer. In 1900, in order to increase storage capacity, the main spillway was raised 1.5 feet. As originally constructed, there was a 2-foot elevation difference between the main spillway and

the auxiliary spillway. After the modification, the elevation difference was reduced to 0.5 foot. The roadway bridge over the main spillway was also raised in the 1900 modification so that the original clearance between the spillway crest and bridge, which was 2.5 feet, would be maintained.

In 1914, the Pennsylvania Water Supply Commission performed hydrologic, hydraulic, and stability analyses for the masonry gravity dam and auxiliary spillway and for the masonry gravity main spillway. As a result of the analyses, improvements were recommended to ensure the stability of the main spillway under maximum pool conditions. The improvements, which consisted of removing the top 1.5 feet of masonry and replacing it with concrete and also placing additional reinforced concrete doweled onto the downstream face of the masonry gravity section, were completed to the satisfaction of the Commission in 1916.

In 1977, Pennsylvania Gas and Water Company made repairs to the masonry gravity retaining wall adjacent to the masonry gravity section of the main dam. The wall had cracked and bulged, and the repairs consisted of installing a gravel drain below the backfill along the back face of the wall and re-building the damaged portion of the wall.

Various modifications and repairs have been made to the water supply and distribution facilities throughout the life of the dam.

h. <u>Normal Operational Procedure</u>. The primary purpose of the reservoir of Lake Scranton Dam is water storage and distribution. Water can be brought into the Lake Scranton reservoir from Williams Bridge Dam and Elmhurst Dam for storage and distribution. The pool level at Lake Scranton Dam is normally maintained at the crest of the main spillway. Water for distribution is withdrawn from both the outlet works at the masonry gravity dam and from the outlet works at the pavilion gatehouse. The 36-inch and 24-inch emergency lines, or blowoffs, are used to draw down the reservoir and to remove sediment from the bottom of the reservoir. The valves on the blowoffs are normally closed.

1.3 <u>Pertinent Data</u>.

a. <u>Drainage Area</u>. 6.0 square miles (5.0 square miles of which drains into Williams Bridge Reservoir).

b. <u>Discharge at Damsite</u>. (cfs.)

Maximum known flood at damsite - 833 (estimated - May 1942).

Emergency drawdown lines at maximum pool elevation - 470 (approximate).

Main spillway capacity with pool at auxiliary spillway crest - 115.

Total spillway capacity (main and auxiliary) at maximum pool elevation - 4,480.

c. Elevation. (Feet above msl.)

Top of dam (gravity section) - 1288.8.
Top of dam (embankment) - varies from 1286.1 to 1290.0.
Maximum pool - 1286.1.
Normal pool (main spillway crest) - 1282.8.
Auxiliary spillway crest - 1283.3.
Upstream intake invert outlet works - 1227.0.
Downstream invert outlet works - 1220.0.
Portal invert pavilion pumphouse - 1247.2.
Streambed at centerline of masonry dam - 1229.0 (approximate).

d. Reservoir Length. (Miles.)

Normal pool - 1.20 miles.
Maximum pool - 1.22 miles.

e. Storage. (Acre-feet.)

Normal pool (main spillway crest) - 7,642.
Maximum pool (top of dam) - 8,397.

f. Reservoir Surface. (Acres.)

Normal pool (main spillway crest) - 225.
Maximum pool (top of dam) - 230.

g. Dam.

Type - Combination masonry gravity and earthfill embankment with central masonry core wall.

Length - Main dam - embankment only - 290 feet.
Embankment and auxiliary spillway - 610 feet.
Main spillway - 100 feet.
Embankment and main spillway - 460 feet.

Height - Main dam - 60 feet.
Main spillway - 20 feet.

Top Width - Embankment - 16 feet.
Auxiliary spillway - 12 feet.

Side Slopes - Main dam - upstream - 1V on 3.5H.
downstream - 1V on 3H.
Spillway dam - upstream - 1V on 3H.
downstream - 1V on 3H.

h. Diversion and Regulating Tunnels.

Type - Cast-iron pipes - 36-inch diameter blowoff.
36-inch diameter water supply.
24-inch diameter blowoff.
30-inch diameter supply.
8-inch diameter supply.

Length - Cast-iron pipes -
36-inch diameter blowoff - 600 feet.
36-inch diameter water supply - connects to distribution system.
24-inch diameter blowoff - 600 feet.
30-inch water supply line to headworks at No. 7 Dam - 7,500 feet.
8-inch diameter - connects to water tank above lake - 2,000 feet.

Access - Cast-iron pipes -
36-inch diameter blowoff and water supply - access to upstream end by closing bulkhead and slide gates at intake structure.
24-inch diameter - none.
30-inch diameter - access at pavilion gatehouse by closing bulkhead and slide gates
8-inch diameter - none.

Regulating Facilities - Cast-iron pipes -
For each 36-inch diameter - Two manually operated rising stem, 2 threads per inch (TPI), 2 x 5 feet slide gates with exposed 4:6 to 1 gear reducers in intake structure and manually operated, rising stem, 2TPI, gate valves with 5.86 exposed gear reducers and 2:1 ratio chain drives, in downstream gatehouse.
24-inch diameter - Two manually operated, rising stem, 2TPI, 5:1 gear reducers in downstream gatehouse.
30-inch diameter - Manually operated, rising stem, 2TPI, slide gate with exposed 3:1 gear reducer.
8-inch diameter - Manually operated, rising stem, 2TPI, slide gates with exposed 3:1 gear reducer, and two pumps, each rated at 200 gpm at 325 feet head.

i. Spillway.

Type - Main spillway - ogee weir.
Auxiliary spillway - broad crested weir (width 12 feet) with free overfall.

Length of Weirs - Main spillway - 100 feet.
Auxiliary spillway - 324 feet total.
187 feet minus buttresses.

Crest Elevations - Main spillway - 1282.8.
Auxiliary spillway - 1283.3.

Upstream Channel - Main - 1V on 3H rock-lined slope, embankment.
Auxiliary - Flat with embankment retained on left end of spillway by masonry retaining wall. Dry masonry wall on right side of spillway. Both walls project upstream at 90° to axis of dam.

Downstream Channel - Main - gently sloping channel with rock bottom narrows to 30 feet wide by 2 feet deep channel with 100 feet wide overbank.
Auxiliary - gently sloping channel with rock outcrops and trees. Masonry retaining wall on left retains earth embankment; right side is steep with sandstone and conglomerate outcrops.

j. Regulating Outlets. Outlet works as described above in Paragraph h. Also, Lake Scranton is interconnected with Elmhurst Reservoir by a piping system that is regulated at No. 7 Dam. Water can be brought into Lake Scranton via the piping system. Water from Lake Scranton can enter the distribution system either directly or by way of the piping system at No. 7 Dam.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. Very little engineering data was available for review for the original structures or for the 1900 modifications. In a study performed in 1914 by the Pennsylvania Water Supply Commission, an account of design concepts, geology, construction materials and methods, and design features was prepared for the structures from interviews with the Owner, visual inspection, and other sources. The 1914 study also included analyses for hydrology, hydraulics, and stability of the principal features. Load assumptions and a summary of the results of the analyses are on file. That study and additional studies performed by the Commission in 1915 were the bases for the recommended improvements to the main spillway that were made in 1916.

b. Design Features. Lake Scranton Dam consists of two independent impoundment structures, the main dam and the earthfill structure adjacent to the main spillway. They are connected by high natural ground. Outlet works are located at the main dam and at a separate shoreline facility known as the pavilion gatehouse. The locations of the various features are shown on Plate 1A.

The main dam consists of 320-foot long masonry gravity section (Photographs A and B) and a 290-foot long earthfill embankment with a central masonry core wall (Photographs D and E). The maximum height of the main dam is about 60 feet. The plan of the main dam is shown on Plate 2. The profile along the axis of the main dam is shown on Plate 3. Typical sections of the main dam are shown on Plates 4 and 5. Drawings indicate the masonry gravity portion of the main dam is founded entirely on rock. The masonry gravity structure is keyed into rock outcrops at the right abutment. The structure is 12 feet wide at the top. The bottom width varies but is generally about 60 feet. The rock outcrops and the rock foundation are sandstone and conglomerate. A discussion on geology is presented in Appendix E. At the top of the gravity dam, 11 arched openings act as an auxiliary spillway. Two other arches are present, for architectural purposes, but they do not act as waterways. The auxiliary spillway crest is at Elevation 1283.3, or 0.5 foot higher than the crest of the main spillway. These arches also support a roadway across the dam. Parapet walls are built on each side of the roadway. Along the right bank upstream from the masonry gravity structure, a masonry retaining wall supports a roadway fill (Photograph C).

A sloping masonry gravity retaining wall projects upstream and downstream from the left end of the masonry dam to retain the adjacent earthen embankment. The downstream wall also serves as the training wall for the auxiliary spillway of the dam (Photograph D). A

gravel drain behind the downstream retaining wall collects subsurface water and carries it to a gravel-filled sump located at the toe of the embankment (Photograph E).

The earthfill embankment adjacent to the masonry gravity structure has an upstream slope of 1V on 3.5H and a downstream slope of 1V on 3H. The crest, which is at Elevation 1288.5, has a paved roadway on it. The upstream slope has 12 inches of riprap and the downstream slope is seeded. About 40 feet beyond the end of the adjacent masonry gravity structure, the foundation rock drops abruptly. Consequently, most of the central masonry core wall is built upon a concrete footing that was placed on hardpan. The core wall is constructed to within about 2 feet of the top of the embankment, and its width varies from 5 feet at the top to about 16 feet at the bottom. The core wall and embankment tie into the high ground at the left abutment of the main dam.

The dam that includes the main spillway is located about 1,200 feet to the left of the main dam, and it is primarily an earthfill embankment with a central masonry core wall. A plan and typical sections of the dam are shown on Plates 6 and 7, respectively. Photograph H also shows this dam. The earthen portion of the dam is about 360 feet long. The upstream slope is about 1V on 3.5H, and it is protected with 12 inches of riprap (Plate 7). The upstream earthfill is continuous across the dam and main spillway. The downstream earthfill slopes are 1V on 3H to the right of the main spillway and 1V on 1.5H to the left of the main spillway. The crest level of the earthfill embankment varies from Elevation 1290.0 near the left abutment to Elevation 1286.1 near the right abutment. Elevation 1286.1 is the lowest top of dam elevation for the project. A paved roadway crosses the main spillway on a bridge. Part of the central masonry core wall is built on a concrete footing placed on hardpan, and the remainder of it is founded on rock. The maximum height of the core wall is about 20 feet.

The main spillway is located to the left of the center of the 460-foot long dam structure. The height of the main spillway is about 20 feet; the length is about 100 feet; and the crest is at Elevation 1282.8. A steel truss bridge spans the spillway, with low steel 2.5 feet above the spillway crest (Photograph I). The original spillway was a masonry gravity, stepped spillway. That spillway was raised 1.5 feet in 1901 in order to increase storage capacity. The bridge was also raised at the same time to maintain the same clearance over the crest. As a result of studies and recommendations made by the Pennsylvania Water Supply Commission, modifications to increase stability were made to the main spillway in 1916. The top 1.5 feet of stone were removed and replaced with concrete, and reinforced concrete was doweled to the downstream face of the masonry gravity section. The modification resulted in a heavier section with an ogee shape for the spillway. The exit channel below the main spillway (Photograph L) joins the exit channel below the main dam (Photograph G) about 2,000 feet downstream.

One outlet works, which contains the reservoir drawdown facilities, is located near the center of the masonry gravity section of the main dam. A section through the outlet works is shown on Plate 4. The screen chamber building has a total of six intake ports at three levels and is located along the upstream face of the masonry gravity structure. The intake ports have steel trashracks. Slots are provided to install bulkheads over the upper intake ports, and the lower intake ports are controlled by slide gates. Two cast-iron pipes, a 36-inch water supply line and a 36-inch emergency line can withdraw water from the screen chamber. Another cast-iron pipe, 24 inches in diameter, is located about 35 feet to the right of the screen chamber. This pipe is also an emergency line. Two gatehouses with gate valves to control flow in the water supply and emergency lines are located at the downstream toe of the masonry gravity structure (Photograph B). Each line has two manually operated gate valves on it. The 36-inch water supply line has a Venturi meter and expands to a 48-inch diameter transmission line that supplies water to Scranton. The 36-inch and 24-inch emergency lines are underground to about 600 feet downstream from the main dam, where they outlet at a small pond (Photograph F).

Another outlet works, the pavilion gatehouse, is located along the shoreline of Lake Scranton. The purpose of this outlet works is to control a portion of the flow into and out of the reservoir. Water can be transferred to Lake Scranton from other reservoirs and then distributed from Lake Scranton. The design of this outlet works is such that it would not be used to drawdown the reservoir of Lake Scranton Dam.

2.2 Construction.

a. Data Available. Construction data available for review for the original structures was limited to information contained in the 1914 report prepared by the Pennsylvania Water Supply Commission. That information was obtained by interviews with the Owner, and it gives details of the construction operations. Details of construction requirements for the 1916 main spillway modification are available.

b. Construction Considerations. The 1914 report by the Commission raised several concerns about the construction of Lake Scranton Dam. One concern was that no special design provisions were included for the embankment section of the main dam where the core wall foundation made a transition from rock to hardpan. It was also reported by the Chief Engineer of Scranton Gas and Water Company that problems were encountered because the cement did not meet specification requirements. Despite the above considerations, the 1914 report, in general, praises the quality of construction used in the structures. For example, information is cited that indicates the stone was carefully selected and was of high quality, the embankment fills were kept moist during dry periods, the embankment areas were grubbed, and excavation for foundations was carried to such depths as necessary to ensure adequate support. In

general, the accounts of construction are such that it appears reasonable care was used for construction of all original features of Lake Scranton Dam.

Review of available information for the 1916 improvements to the main spillway did not yield pertinent information with respect to the character of that work.

No information was reviewed for the 1977 repairs to the embankment retaining wall adjacent to the masonry gravity section of the main dam.

2.3 Operation. No formal records of operation were reviewed. Based on information from the Owner and the caretakers of the dam, all structures have performed satisfactorily except for the masonry retaining wall at the main dam. Since its repair in 1977, it has performed satisfactorily. The caretakers, who have been associated with Lake Scranton Dam for many years, said that they could not recall when flow over the auxiliary spillway last occurred.

2.4 Other Investigations. The Owner said that plans have been prepared for increasing the spillway capacity of Lake Scranton Dam. Neither the engineering data for these plans or the plans themselves were reviewed by the inspection team.

2.5 Evaluation.

a. Availability. Engineering data was provided by the Division of Dams and Encroachments, Bureau of Water Quality Management, Department of Environmental Resources, Commonwealth of Pennsylvania and by the Owner, Pennsylvania Gas and Water Company. The Owner made available an engineer, caretakers, and a valve crew for information and operating demonstrations during the visual inspection. The Owner also researched his files for additional information upon request of the inspection team.

b. Adequacy. The type and amount of design data and other engineering data are limited, and the assessment must be based on the combination of available data, visual inspection, performance history, hydrologic assumptions, and hydraulic assumptions.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The general appearance of this project indicated that some project features have deteriorated with age and are in need of repair, while other project features have been properly maintained and are in good condition.

b. Dam.

(1) The embankment sections that are adjacent to the main spillway are generally in good condition (Photograph H). No seepage, wet areas or other deficiencies were observed anywhere on the embankment. The sod is intact and well maintained. There has been some loss of riprap at the main spillway abutments. The Owner stated that people who use the roadway as a hiking path throw the stone into the lake. Minor sloughing and erosion has resulted from the loss of riprap. Four small shrubs were growing on the upstream face, and two 4-inch trees were growing on the downstream face left of the spillway (Photograph K). The downstream embankment slopes are 1V on 3.5H to the right of the spillway, and 1V on 1.5H to the left of the spillway. Heavy forest begins at the toe of the embankment to the left of the spillway and about ten feet beyond the toe to the right of the spillway. A survey of the top of the embankment showed that the left end was 4 feet higher than the right end. The survey also showed that the right end of the embankment, which is at Elevation 1286.1, is the lowest top of dam elevation for the project. Consequently, overtopping would occur at this location first.

(2) Several damp areas and seepage points were observed on the downstream face of the masonry gravity section of the main dam. However, at no place was the leakage estimated to exceed about 1/4 gallon per minute, and no damage or other adverse effects have resulted from the leakage. The stone masonry and mortar joints were in excellent condition, and they had no signs of weathering, cracking, or other defects. The auxiliary spillway consists of a series of arched openings through the upper portion of the masonry gravity dam. Photographs A and B show the downstream face of the dam and the auxiliary spillway.

(3) The embankment section adjacent to the masonry gravity dam was covered with a good growth of sod and was well maintained. The downstream slope is irregular, but is approximately 1V on 3H. At the toe of the slope adjacent to the masonry retaining wall, there was a wet area about 20 feet square (Photograph E). The Owner, while repairing the wall in 1977, installed a gravel drain behind the wall and

connected it to a gravel filled sump at this location. The wet area is overflow from this sump. The overflow, while uncontrolled, has not caused damage to other features.

c. Appurtenant Structures.

(1) The main spillway is suffering from advanced concrete deterioration (Photograph J). The concrete was placed in 1916 and was doweled to the existing masonry gravity spillway to ensure the stability of the structure. About 2/3 of the downstream face has very severe scaling to a maximum depth of about 7 inches. At the left end, 1-foot lengths of the steel reinforcement are exposed and are in early stages of corrosion. Wide horizontal cracks are present at most of the construction joints, and they are weathered and scaled to a maximum depth of 10 inches. Leakage from these joints was observed, particularly at the first joint below crest level. The most concentrated leakage point had an estimated flow of 2-3 gallons per minute (Photograph J, p.D-5). The leakage has not affected other features. Two lines of 1-1/2-inch diameter drain holes, totalling 33 holes, are on the downstream face, but discharge from them ranged from slight to nothing. A roadway bridge across the spillway crest has its low steel about 2.5 feet above the crest (Photograph I).

(2) The masonry retaining wall adjacent to the left end of the gravity dam (Photographs D and E) was repaired in 1977. There was slight seepage at the base near the wet area behind the wall. No damage to other features has resulted from the seepage. The masonry and joints are sound.

(3) Valve covers and exposed gears were coated with rust, but other operating mechanisms were lubricated. Paint was peeling off gate stands. The Owner said that the valves were operated recently. A few inches of water was standing in the gatehouses.

d. Reservoir Area. The reservoir slopes are covered with hardwoods and evergreens. No evidence was visible of creep, rock slides, or land slides. The Owner indicated that sedimentation is not a problem. The watershed is partially owned and controlled by the Owner and predominantly undeveloped.

e. Downstream Channel. The channel immediately below the main spillway is covered with large, loose rock and was dry (Photograph L). Several hundred feet downstream, discharge from some small springs converge to form a small permanent watercourse through the dense forest. The channel below the gravity dam was also dry for several hundred feet. It is very irregular, and the forest starts about 300 feet downstream (Photograph G). The two channels converge well downstream of the dam. A gas tank, which the Owner thought contained propane, is located in the downstream channel area near the toe of the gravity dam.

3.2 Evaluation.

a. Dam.

(1) The continued growth of trees and shrubs on the embankment slopes and along the toe of the embankment is undesirable. The downstream slope of the embankment to the left of the main spillway is steep, but the embankment height at this section is not great, and, also, the left end of the dam is considerably higher than the right end. The right end of the dam is the lowest top of dam elevation, and overtopping would occur there first. Unless the lost riprap on the upstream surface is replaced, the upstream slopes adjacent to the spillway will progressively erode and slough.

(2) The slight seepage showing on the downstream face of the main dam is not of great concern at the present time. The arched openings of the masonry gravity dam, that comprise the auxiliary spillway, could be easily blocked by debris.

(3) Water from the subsurface drain behind the masonry retaining wall enters a gravel filled sump. Apparently, the seepage at the toe is a result of the sump being filled to capacity and overflowing. The exact source of this subsurface water is unknown, and the quantity of water and extent of saturation are also unknown. This condition is of general concern because of the proximity to important features.

b. Appurtenant Structures.

(1) The concrete on the main spillway, particularly on the left side, has deteriorated to the extent that its structural integrity could be affected. Examination of previous inspection records shows that the deterioration began at least as early as 1933. The location of the bridge over the main spillway is such that it might act as a hydraulic constraint when the depth of water over the crest exceeds 2.5 feet. It could also cause a buildup of debris during floods.

(2) The overall condition of the operating equipment was adequate, but regular maintenance is needed. The two gatehouses located at the toe of the masonry gravity dam might not be accessible during periods of flow over the auxiliary spillway.

c. Reservoir Area. No conditions were observed in the reservoir area that might present significant hazard to the dam.

d. Downstream Channel. The location of the unsheltered gas tank is a personal hazard rather than a hazard to the dam. It could easily be washed away if significant overflow occurred, or it could be damaged by vandals.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. During periods of high runoff the reservoir is maintained by the main spillway crest at Elevation 1282.8 with any excess reservoir inflow passing over main spillway. Normally, however, the reservoir level is maintained below spillway crest and there is no spillage. A 36-inch diameter line through the intake structure at the main dam releases water to a 48-inch diameter gravity transmission line that goes into Scranton. Water is also pumped out of the reservoir by two pumps located in the pavilion gatehouse. In addition to normal runoff, water enters the reservoir from the 30-inch diameter supply line from Elmhurst Reservoir at the pavilion gatehouse. All emergency lines are normally closed.

4.2 Maintenance of Dam. The dam is visited daily by two caretakers who check chlorination equipment, and if water is not flowing over the main spillway, they check the reservoir elevation. When the reservoir is below the main spillway crest, the caretakers report the reservoir elevation to the Owner's Engineering Department. This information is used by the Engineering Department for regulating flows in the distribution system. The caretakers are also responsible for observing the general condition of the dam and appurtenant structures and for reporting any changes or deficiencies to the Owner's Engineering Department. A Pennsylvania Gas and Water Company engineer makes a formal inspection of the dam each year, and the records are kept on file and used for determining priority of repairs. Informal inspections are also made when the engineer is on the site for other reasons. The seeded embankments are mowed at regular intervals, and brush is cut annually.

4.3 Maintenance of Operating Facilities. The intake screens are cleaned in the fall when leaves tend to clog them or whenever there is indication of a pressure drop. There is no regular maintenance program for other operating facilities.

4.4 Warning Systems in Effect. The Owner furnished the inspection team with a chain of command diagram for Lake Scranton Dam and a generalized emergency notification list that is applicable for all the Pennsylvania Gas and Water Company dams. The Owner said that during periods of heavy rainfall, available personnel are dispatched to the dams to observe conditions. All company vehicles are equipped with radios, and the personnel can communicate with each other and with a central control facility. Evaluation of risk is made by the Owner's Engineering Department. The Owner's Engineering Department is also responsible for notification of emergency conditions to the local authorities. Detailed emergency operational procedures have not been formally established for Lake Scranton Dam but are as directed by the Owner's Engineering Department.

4.5 Evaluation. Except for not opening the valves on the blowoff line to the full opening on a regular basis, the operational procedure appears to be satisfactory. Infrequent operation of these blowoffs could effect their functioning satisfactorily during emergency conditions. The procedures used by the Owner for inspecting the dam are adequate, but some repairs have not been timely. As observed in the visual inspection, the maintenance for the operating facilities is adequate. In general, the warning system is adequate, but is not in sufficient detail for Lake Scranton Dam when its overall importance is considered.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data.

(1) No hydrologic or hydraulic analyses for the original Lake Scranton Dam were available for review. The spillway capacity was estimated before and after the 1916 modification of the main spillway. Spillway capacity, as used in this Section, represents the combined capacity of the main and auxiliary spillways.

(2) In the recommended guidelines for safety inspection of dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended spillway design flood for the size (intermediate) and hazard potential (high) classification of Lake Scranton Dam is the PMF. If the dam and spillway are not capable of passing the PMF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

(3) The Lake Scranton watershed is primarily owned by the Pennsylvania Gas and Water Company and is undeveloped. Hydrologic analysis for this study was based on existing conditions and the effects of future development of the watershed were not considered.

b. Experience Data. In 1972, Justin & Courtney prepared a hydrology report and an improvement study that showed the 6-hour Probable Maximum Flood (PMF) peak discharge at 17,000 cfs for the Williams Bridge watershed. The Williams Bridge watershed is 5.0 square miles and is part of the Lake Scranton watershed which is 6.0 square miles. The PMF peak for the Lake Scranton watershed was determined to be 19,670 cfs, with 16,390 cfs being the Williams Bridge watershed component (Appendix C). Before the 1916 main spillway improvement,

the spillway capacity was estimated to be 2,300 cfs. In 1971, the Owner estimated a spillway capacity of 7,100 cfs for a reservoir Elevation of 1286.1. The lowest point of the top of the dam was found to be Elevation 1286.1. It is located at the right end of the embankment dam that has the main spillway. Calculations were performed to check the spillway capacity, and a discharge of 4,480 cfs for a reservoir Elevation of 1286.1 was calculated and used for this study (Appendix C).

c. Visual Observations. On the date of the inspection, it was observed that the auxiliary spillway is quite vulnerable to blockage and capacity reduction during a flood occurrence due to debris accumulation. Another potential source of spillway blockage and capacity reduction is the constriction caused by the highway bridge that spans the main spillway. The low steel of the bridge is 2.5 feet above the spillway. However, no trash or debris were observed on the reservoir on the date of the inspection.

d. Overtopping Potential. For an occurrence of the Lake Scranton PMF, the peak inflow of 16,390 cfs into Williams Bridge Reservoir is greater than the spillway capacity of Williams Bridge Dam. A check of the surcharge storage effect of Williams Bridge Reservoir shows that the surcharge storage available is insufficient to contain an inflow with a peak flow of 16,390 cfs without overtopping the dam (Appendix C). Williams Bridge Dam would probably fail due to overtopping based on actual dam failures (Appendix C), a failure hydrograph with a peak inflow as high as 110,000 cfs could rush into Lake Scranton, totally emptying Williams Bridge Reservoir in 17 minutes. The spillway capacity of 4,480 cfs is much less than the peak inflow of 110,000 cfs. A check of the surcharge storage effect of Lake Scranton shows that the surcharge storage available is insufficient to contain an inflow with a peak flow of 110,000 cfs without overtopping Lake Scranton Dam. A second failure hydrograph with a total time of 2 hours was also constructed to reflect a more gradual failure. With a constant volume of 1,276 acre-feet stored behind Williams Bridge Dam, the second failure hydrograph peak was calculated to be 15,440 cfs. If Williams Bridge Dam would fail, resulting in this peak outflow of 15,440 cfs, the spillway capacity and surcharge storage effect of Lake Scranton Dam again would be insufficient to prevent overtopping of the Lake Scranton Dam. Also, according to the 1914 calculations of G.F. Wieghardt of the Pennsylvania Water Supply Commission, a failure of the top 13.5 feet of Williams Bridge Dam would produce a head of more than 2.5 feet on the top of Lake Scranton Dam. If Williams Bridge Dam does not fail due to overtopping, the resulting flow of nearly 16,390 cfs from Williams Bridge Reservoir into Lake Scranton would be sufficient to force overtopping of Lake Scranton Dam. If Lake Scranton Dam should fail because of overtopping, the overtopping potential and potential for failure of No. 5 Dam would be greatly increased.

e. Downstream Conditions. As shown on Plate 1, Lake Scranton Dam is located 1.3 miles downstream from Williams Bridge Dam, and No. 5 Dam is located 3.0 miles downstream from Lake Scranton Dam. Tracks of the Erie - Lackawanna Railroad and the Lackawanna and Wyoming Valley Railroad cross Stafford Meadow Brook about 0.5 mile below No. 5 Dam. Starting at about 1.0 mile below No. 5 Dam, Stafford Meadow Brook runs parallel to Interstate Route 81 for a reach of about 1.0 mile. At the end of this reach, Stafford Meadow Brook runs under Interstate Route 81 and into the City of Scranton, which is the first populated area below Lake Scranton Dam. The City of Scranton is about 5.0 stream miles below Lake Scranton Dam and about 2.0 stream miles below No. 5 Dam. The downstream conditions indicate that a high hazard classification is warranted for Lake Scranton Dam.

f. Spillway Adequacy.

(1) Williams Bridge Dam will not pass its component of the PMF for Lake Scranton watershed without overtopping. The Williams' Bridge component of one-half the Lake Scranton PMF is 8,195 cfs, and it is greater than the spillway capacity of Williams Bridge Dam. A check of the surcharge storage effect of Williams Bridge Reservoir shows that the surcharge storage available is insufficient to contain an inflow with a peak flow of 8,195 cfs without overtopping. As discussed in Paragraph 5.1.d., if Williams Bridge Dam should fail because of overtopping, Lake Scranton Dam would be overtopped, and the potential for failure of Lake Scranton Dam would be greatly increased. In turn, if Lake Scranton Dam should fail because of overtopping, the overtopping potential and potential for failure of No. 5 Dam would be greatly increased.

(2) The maximum tailwater is estimated to be Elevation 1234.4 at the spillway capacity of 4,480 cfs. At maximum pool elevation, there is a difference of about 50 feet between headwater and tailwater. If Lake Scranton Dam should fail due to overtopping, the hazard to loss of life downstream from the dam will be significantly increased from that which would exist just prior to overtopping.

(3) Based on established OCE criteria as outlined in Paragraph 5.1.a.(2), the spillway capacity of Lake Scranton Dam is rated as seriously inadequate. For Williams Bridge Dam, considering the effects of the surcharge storage of 242 acre-feet, the Williams Bridge spillway discharge capacity of 5,600 cfs can accommodate a flood with a peak inflow of 5,800 cfs for a storm of the same duration as the Williams Bridge PMF. This is 34 percent of the Williams Bridge PMF peak inflow. Considering the effects of the combined Lake Scranton and Williams Bridge Reservoir surcharge storage of 997 acre-feet, the Lake Scranton spillway discharge capacity of 4,480 cfs can accommodate a flood with a peak inflow of 5,430 cfs for a storm of the same duration as the Lake Scranton PMF. This is 28 percent of the Lake Scranton PMF.

(4) It might be noted that the average flow from the 6 square mile drainage area of Stafford Meadow Brook above Lake Scranton is on the order of 5 mgd. An average of about 12 mgd is served to the Scranton area from Lake Scranton. The difference represents the average diversion from Elmhurst Dam on Roaring Brook to Lake Scranton. As an element in the operating procedure, the pool level in Lake Scranton is manually maintained at a level below the elevation of the main spillway. This provides storage for overflow from Williams Bridge Dam, the uncontrolled flow from the intervening 1 square mile of drainage area and the controlled flow from Elmhurst Dam. Consequently, there is very infrequent flow over the main spillway and there was no record of the last flow over the auxiliary spillway.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspections of the main dam and spillway dam resulted in some observations that are relevant to structural stability. These observations are listed herein for the various features.

(2) Embankment Section of Main Dam. A seepage area was observed at the toe of the embankment. The detailed description and evaluation of the condition are in Paragraphs 3.1.b.(3) and 3.2.a.(3), respectively.

(3) Main Spillway. The concrete on the main spillway is deteriorated. The detailed description and evaluation are in Paragraphs 3.1.c.(1) and 3.2.b.(1), respectively.

b. Design and Construction Data. No records of design data or stability computations for the original structures or for the 1900 modifications were available for review. However, stability studies for the principal features were performed in 1914 by the Pennsylvania Water Supply Commission, and the results of the analyses are on file. That study and additional studies performed by the Commission in 1915 were the bases for the recommended improvements to the main spillway that were made in 1916.

The two principal features that can be evaluated by stability computations are the masonry gravity section of the main dam and the main spillway. For the masonry gravity section of the main dam, the 1914 analysis was reviewed to assess the stability of the section. The maximum loading condition that was used for the structure included the following: water level at Elevation 1285.3, full hydrostatic pressure on the upstream face, no tailwater, and uplift varying from two-thirds full uplift at the heel to zero at the toe. The results of the analysis were that the resultant is within the middle third of the section from the top of the structure to a level of 49 feet below the top of dam. Below this level, the maximum distance that the resultant was outside the middle third was 4 feet. Toe pressures and resistance to sliding were found to be within acceptable limits.

In general, the loading assumptions that were used for the masonry gravity section of the main dam are satisfactory. It would have been more appropriate to use a headwater level about 1 foot higher or Elevation 1286.1, which is the level at which overtopping of the embankment adjacent to the main spillway begins, but this would have negligible effect on the results. The assumption of no

tailwater is considered to be satisfactory because the masonry arches of the auxiliary spillway would pass little water compared to the size of the downstream channel. The actual computations for stability were not reviewed, but correspondence on file indicates that an independent evaluation of the section was made by Professor F. P. McKibben of Lehigh University, and similar results were obtained by him. Consequently, the conclusion for this study is that while the masonry gravity section of the main dam does not meet OCE recommended guidelines for stability at all levels, which recommend that the resultant be within the middle third, the deviation from the recommended guidelines is not significant.

Stability computations that considered the effect of the concrete that was added to the main spillway to increase stability were also reviewed. These computations were also performed by the Pennsylvania Water Supply Commission. The analysis of the improved section showed the resultant to be located outside the middle third by no more than 1 foot under the maximum loading conditions. The loading assumptions included 3 feet of water on the crest, uplift varying from two-thirds of full uplift at the heel to zero at the toe, and full hydrostatic pressure on the upstream face. Toe pressures and the resistance to sliding were acceptable, and the Commission concluded that the section was satisfactory.

In this study, an additional analysis was performed to include earth pressure from the embankment adjacent to the upstream face of the section and a tailwater depth of 3 feet. Only the bottom of the maximum section was analyzed. The analysis showed the toe pressures and the sliding factor to be within acceptable limits. The analysis showed the resultant outside the middle third. It is located about 2.3 feet inside the base from the downstream toe. However, because the spillway is on a rock foundation and because the toe pressure is within acceptable limits, the resultant being outside the middle third is not considered to be a significant deviation from the OCE recommended guidelines.

c. Operating Records. There is no evidence that any stability problems have occurred for the masonry gravity section of the main dam or for the main spillway during the operational history of the dam. It is known that the masonry retaining wall adjacent to the gravity section of the main dam cracked in 1953 and slowly bulged until it was rebuilt in 1977. However, the original design was improved upon during the repair by the addition of a gravel drain along the back face of the wall, and the wall has performed satisfactorily since its repair.

d. Post-Construction Changes. Adequate information is available concerning modifications made to Lake Scranton Dam after 1916.

e. Seismic Stability. Lake Scranton Dam is located in Seismic Zone 1. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading. However, since there is the potential of earthquake forces moving or cracking the masonry core wall, the theoretical seismic stability of this dam cannot be assessed.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on the visual inspection, available records, calculations and past operational performance, Lake Scranton Dam is judged to be in good condition. However, deficiencies of varying degree of importance were noted. A summary of the features and observed deficiencies is listed below:

Feature and Location	Observed Deficiencies
Embankment Sections Adjacent to Main Spillway:	
Upstream surface	Loss of riprap; minor sloughing and erosion; growth of shrubs.
Downstream surface	Trees on embankment.
Masonry Gravity Section of Main Dam:	
Downstream face	Leakage.
Masonry arches (function as auxiliary spillway)	Small openings.
Embankment Section of Main Dam:	Wet area at toe.
Main Spillway:	
Downstream face	Concrete deterioration and leakage.
Crest	Low bridge.
Outlet Works:	Lack of regular maintenance.
Downstream Channel:	Exposed propane tank.

(2) The overtopping potential analysis shows that Lake Scranton Dam will be overtopped by the PMF and by one-half the PMF. Based on OCE criteria, as outlined in Paragraph 5.1.a.(2), the spillway capacity is rated as seriously inadequate. The existing spillway

can accommodate a flood with a peak inflow of 28 percent of the PMF peak inflow.

(3) Review of the 1914 stability computations for the masonry gravity section of the main dam indicates that for the condition of maximum loading, the resultant is slightly outside the middle third of the base, but the factor of safety for sliding and the toe pressure are within acceptable limits.

(4) Review of the 1914 stability computations for the main spillway and computations made for the purpose of this study indicate that for the condition of maximum loading, the resultant is outside the middle third of the base. However, it is located within the base about 2.3 feet from the downstream toe, and the factor of safety for sliding and the toe pressure are within acceptable limits.

(5) Lake Scranton Dam is located upstream of No. 5 Dam. If Lake Scranton Dam should fail because of overtopping, the overtopping potential and the potential for failure of No. 5 Dam is greatly increased. Williams Bridge Dam is located upstream of Lake Scranton Dam. Results of a Phase I investigation report on Williams Bridge Dam showed that the spillway capacity of Williams Bridge Dam was rated as seriously inadequate, based on criteria established by OCE for these studies. If Williams Bridge Dam should fail because of overtopping, the overtopping potential and the potential for failure of Lake Scranton and No. 5 Dams is greatly increased. The safety of Lake Scranton Dam is, therefore, directly affected by the safety of Williams Bridge Dam.

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, and computations performed prior to and as part of this study.

c. Urgency. Lake Scranton Dam is located upstream of No. 5 Dam and the City of Scranton, and impounds about 2.5 billion gallons of water at normal pool level. If Lake Scranton Dam should fail because of overtopping, the overtopping potential and the potential for failure of No. 5 Dam is greatly increased. The recommendations in Paragraph 7.2 should be implemented as soon as practical or in a timely manner, as noted.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations will be required.

7.2 Recommendations and Remedial Measures.

a. In view of the concern for safety of Lake Scranton Dam, the following measures are recommended to be undertaken by the Owner as soon as practical:

(1) Develop a detailed emergency operation and warning system for the Williams Bridge, Lake Scranton, and No. 5 Dam system.

(2) Perform additional studies to more accurately ascertain the spillway capacity required for Lake Scranton Dam, as well as the nature and extent of mitigation measures required to make the spillways hydraulically adequate. Also include provisions to repair concrete of the main spillway.

b. In order to correct operational, maintenance and repair deficiencies, and to more accurately determine the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Install four or more observation wells, or other instrumentation, in the downstream slope of the embankment adjacent to the masonry gravity section of the main dam. Two wells, or other instrumentation, should be installed at different elevations to the left of the embankment retaining wall to determine the condition of the embankment near the location where water is being collected by the gravel drain behind the wall. The others should be located at the Owner's discretion. Monitor instruments and record data so that any change in condition is detected.

(2) Visually monitor the quantity of seepage that exists at the toe of the embankment near the gravel-filled sump.

(3) Study the possible benefits of providing a floating trash boom upstream from the auxiliary spillway.

(4) Replace missing riprap and remove shrubs on upstream surface of embankment adjacent to main spillway.

(5) Remove trees growing on downstream surface.

(6) Provide anchorage and shelter for propane tank located at toe of main dam.

(7) Maintain and operate gated outlets on a regular basis.

(8) Visually monitor leakage quantity on downstream face of masonry gravity section of main dam and make repairs when necessary.

c. Before remedial work for correcting the hydraulic deficiencies of the spillways is complete, the following measures are recommended to be undertaken by the Owner:

(1) Provide round-the-clock surveillance of Lake Scranton Dam during periods of unusually heavy rains.

(2) Have personnel and equipment available during floods to remove any debris that causes the main or auxiliary spillway to become clogged.

(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency and warning system procedures.

SUSQUEHANNA RIVER BASIN

STAFFORD MEADOW BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE SCRANTON DAM

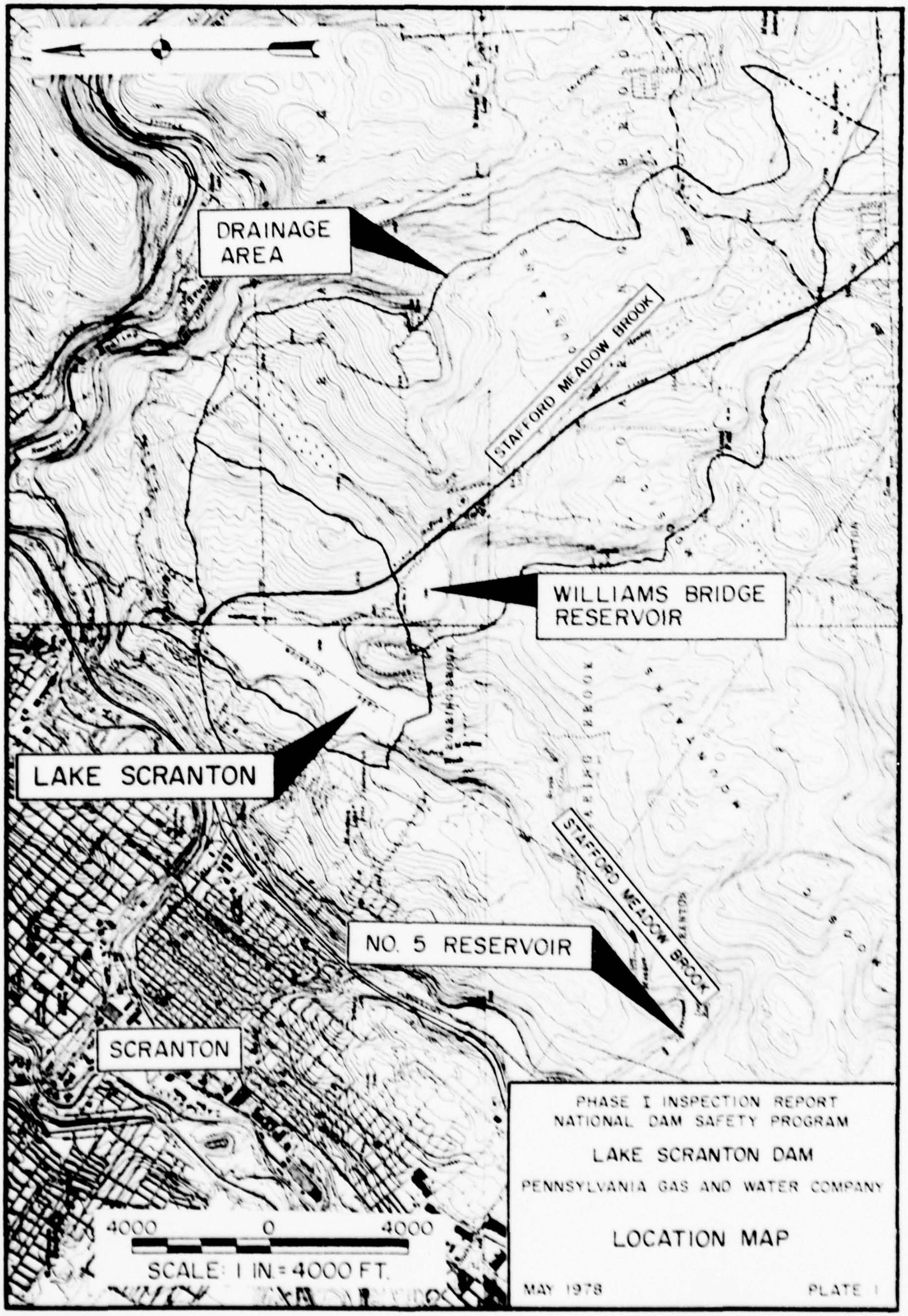
PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

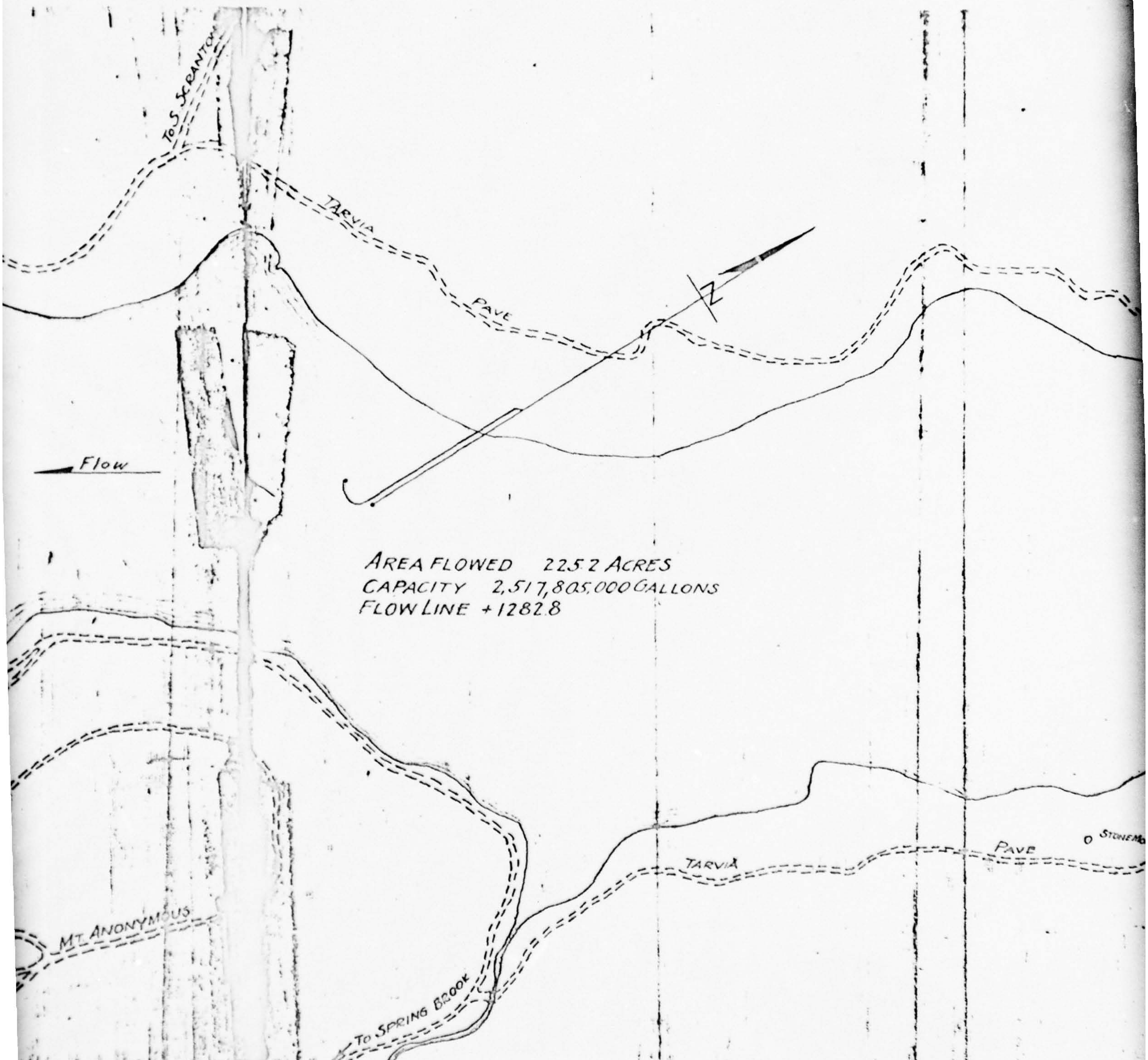
NATIONAL DAM INSPECTION PROGRAM

MAY 1978

PLATES

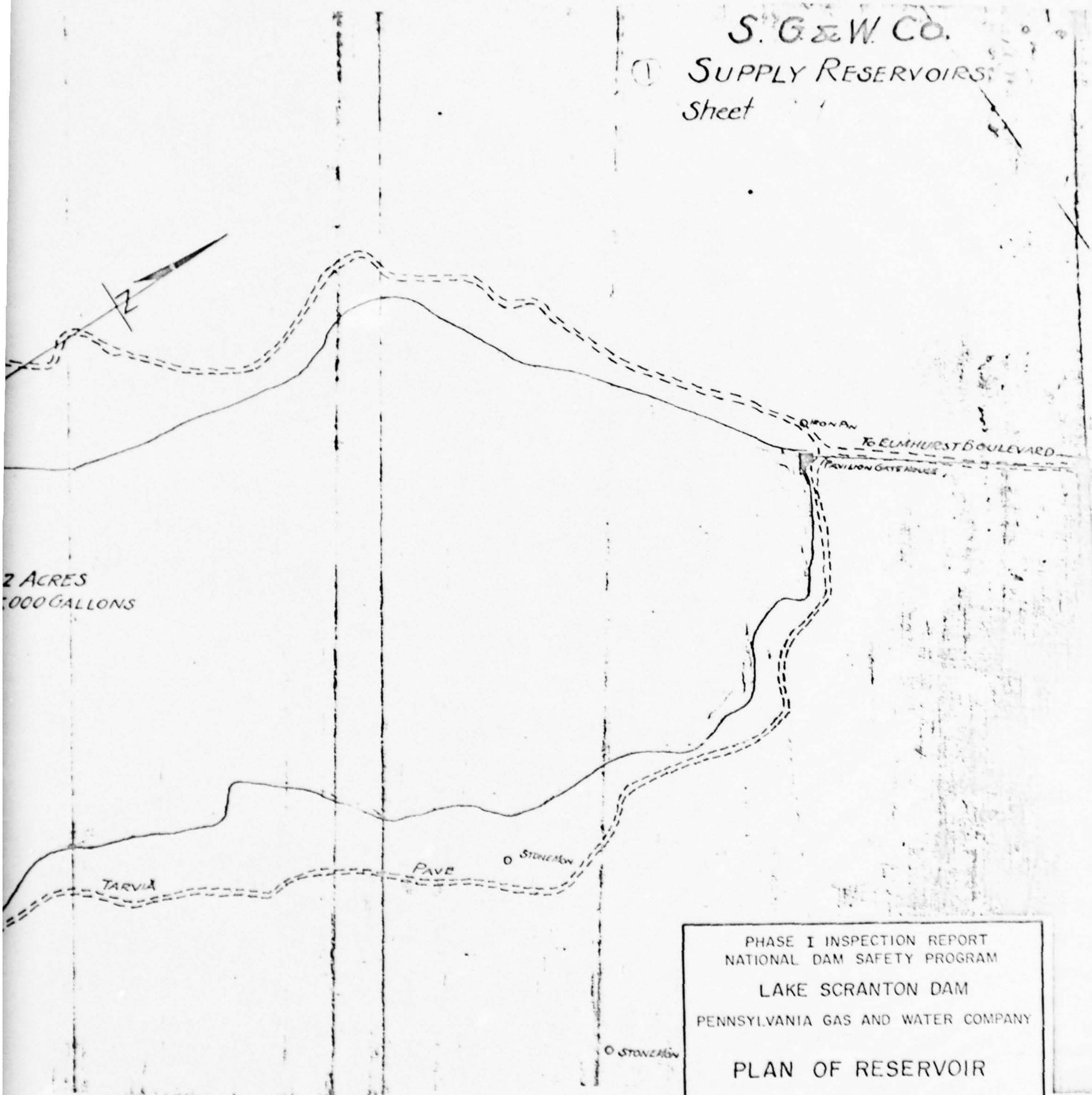

DRAINAGE AREA
STAFFORD MEADOW BROOK
WILLIAMS BRIDGE RESERVOIR
LAKE SCRANTON
STAFFORD MEADOW BROOK
NO. 5 RESERVOIR
SCRANTON
4000 0 4000
SCALE: 1 IN = 4000 FT.
PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE SCRANTON DAM
PENNSYLVANIA GAS AND WATER COMPANY
LOCATION MAP
MAY 1978
PLATE 1

PLAN OF
LAKE SCRANTON
Scale 1 inch=500 feet



To S. Scranton
TARVIA
PAVE
Flow
AREA FLOWED 225.2 ACRES
CAPACITY 2,517,805,000 GALLONS
FLOW LINE +1282.8
TARVIA
PAVE
MT. ANONYMOUS
To SPRING BROOK

2



PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

LAKE SCRANTON DAM

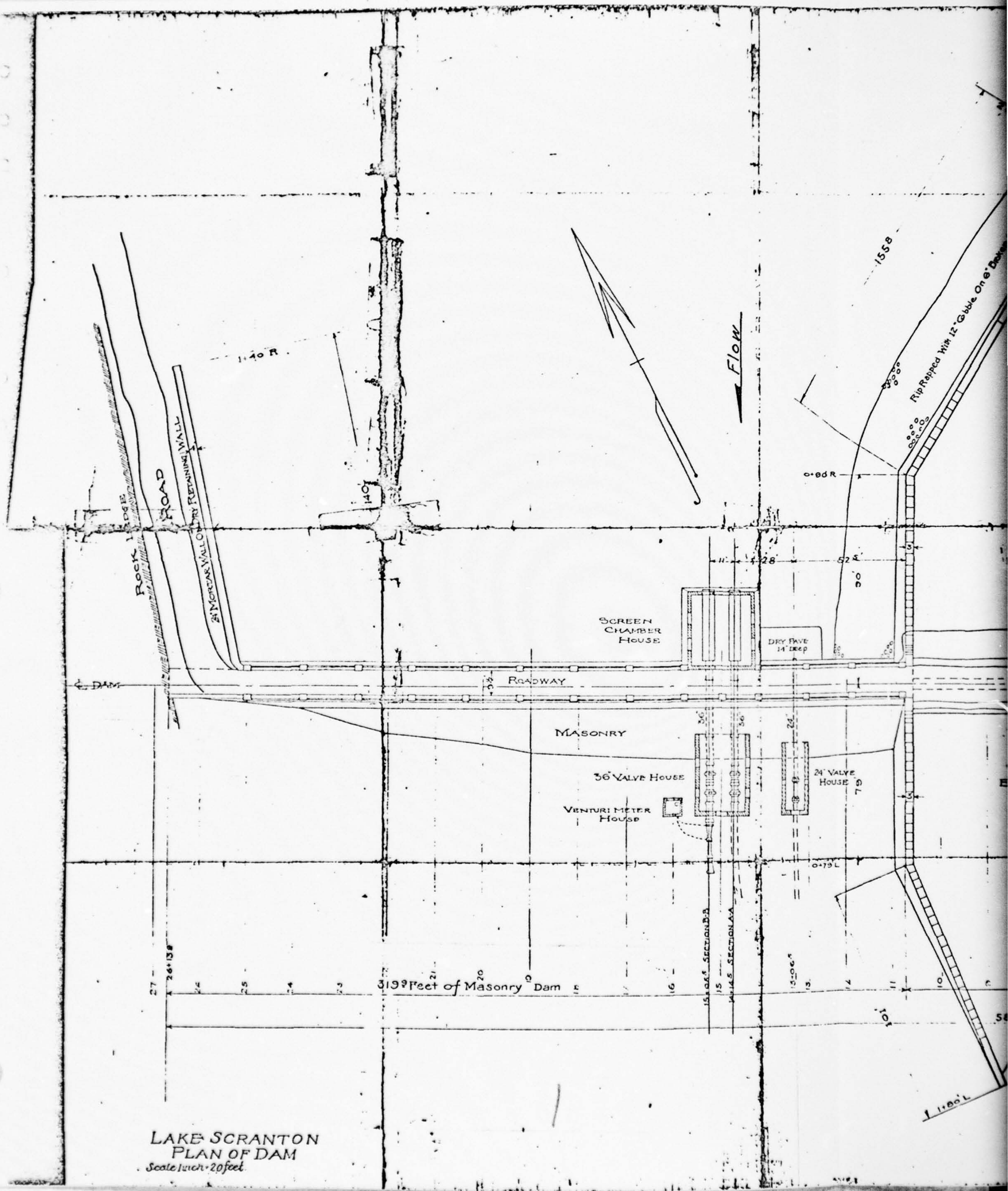
PENNSYLVANIA GAS AND WATER COMPANY

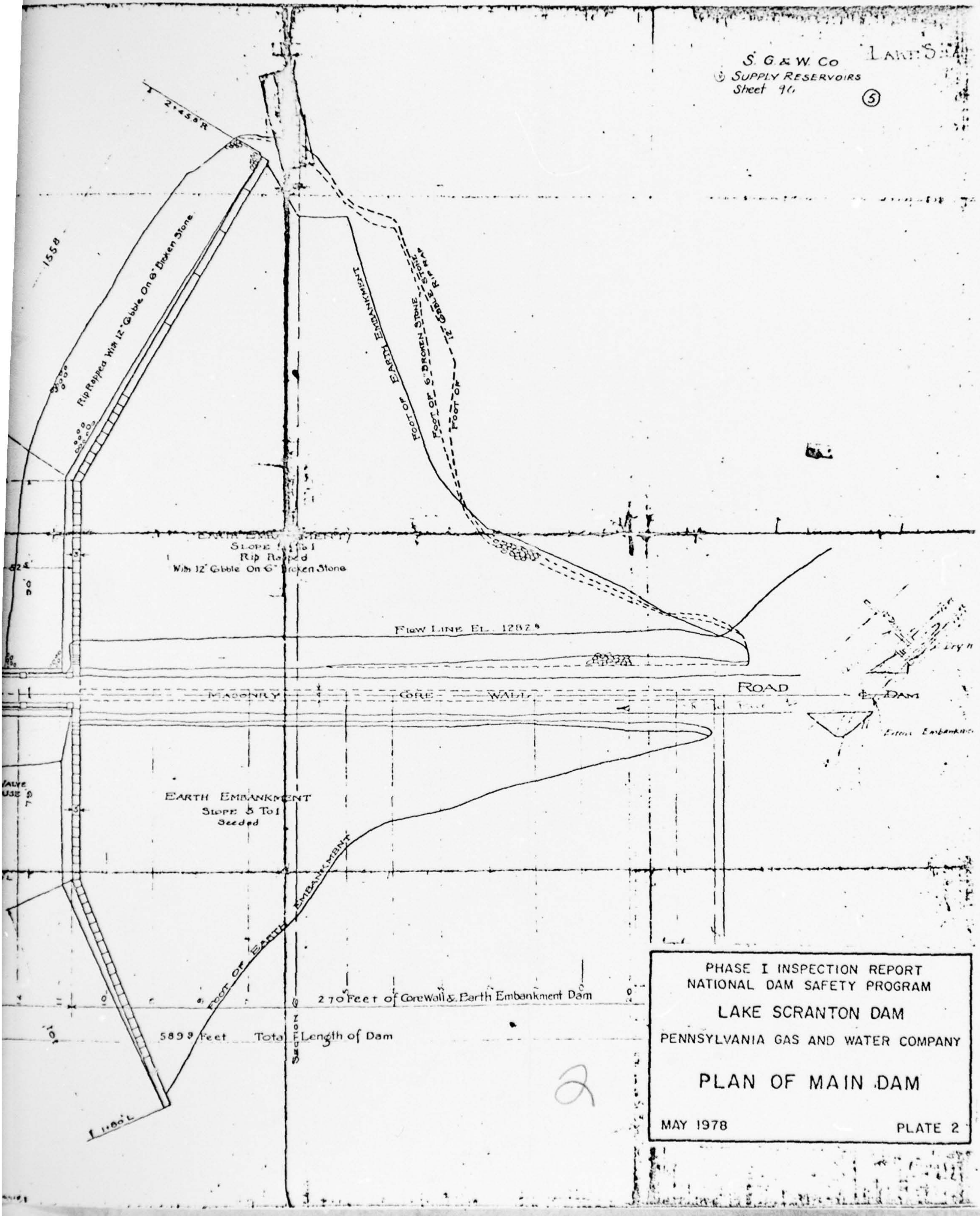
PLAN OF RESERVOIR

MAY 1978 PLATE IA

2

3


Rock Ledge
Road
2' Mortar Wall On Dry Retaining Wall
1+40 R
Flow
1558
Rip Rapped With 12" Cobble On 6"
0+80 R
Screen Chamber House
Dry Pave 14' Deep
Roadway
℄ Dam
Masonry
36" Valve House
24" Valve House
Venturi Meter House
0+79 L
Section B-B
Section A-A
319.9 Feet of Masonry Dam
1+80 L
LAKE SCRANTON
PLAN OF DAM
Scale 1 inch = 20 feet



PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE SCRANTON DAM
PENNSYLVANIA GAS AND WATER COMPANY

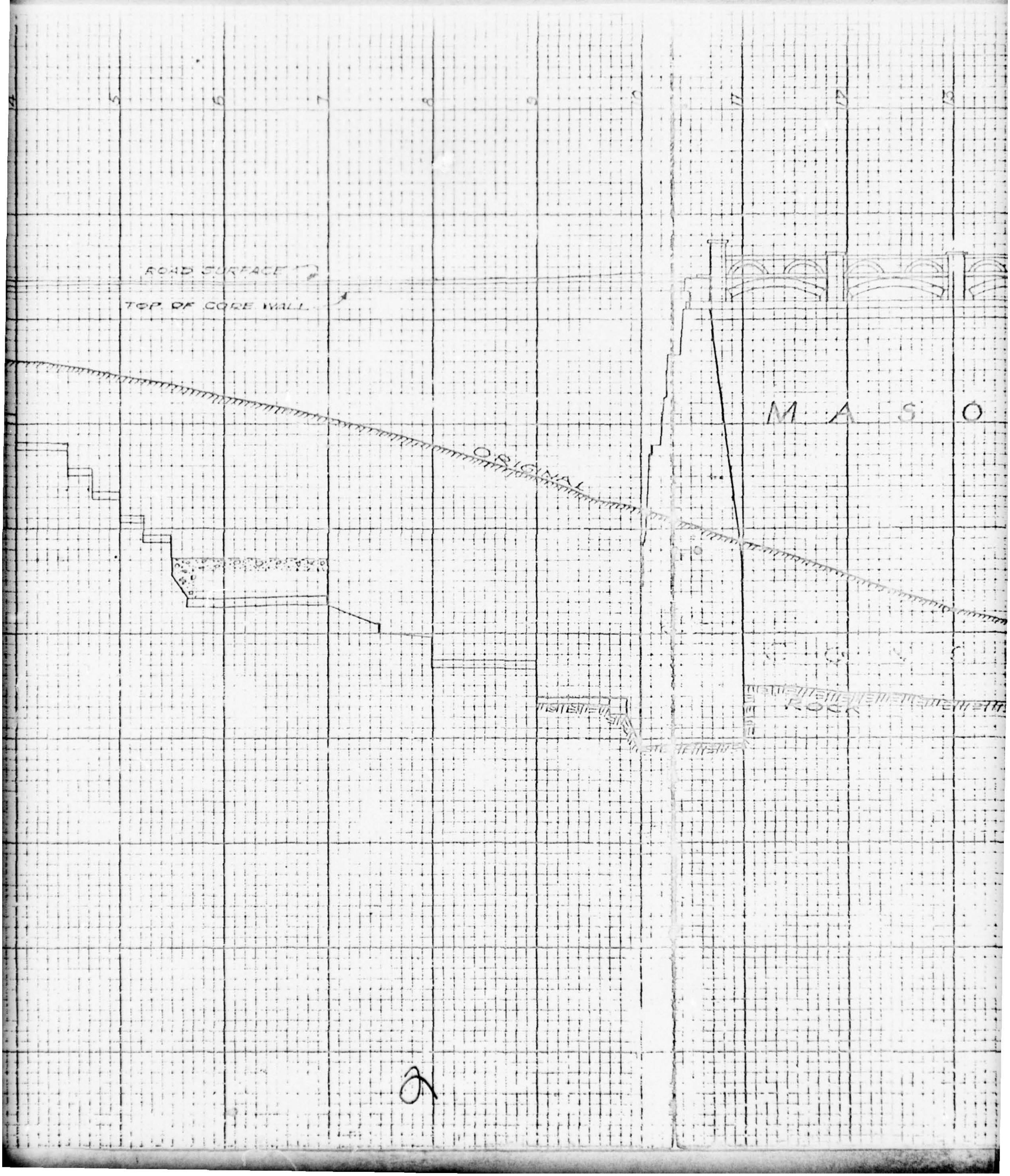
PLAN OF MAIN DAM

MAY 1978 PLATE 2

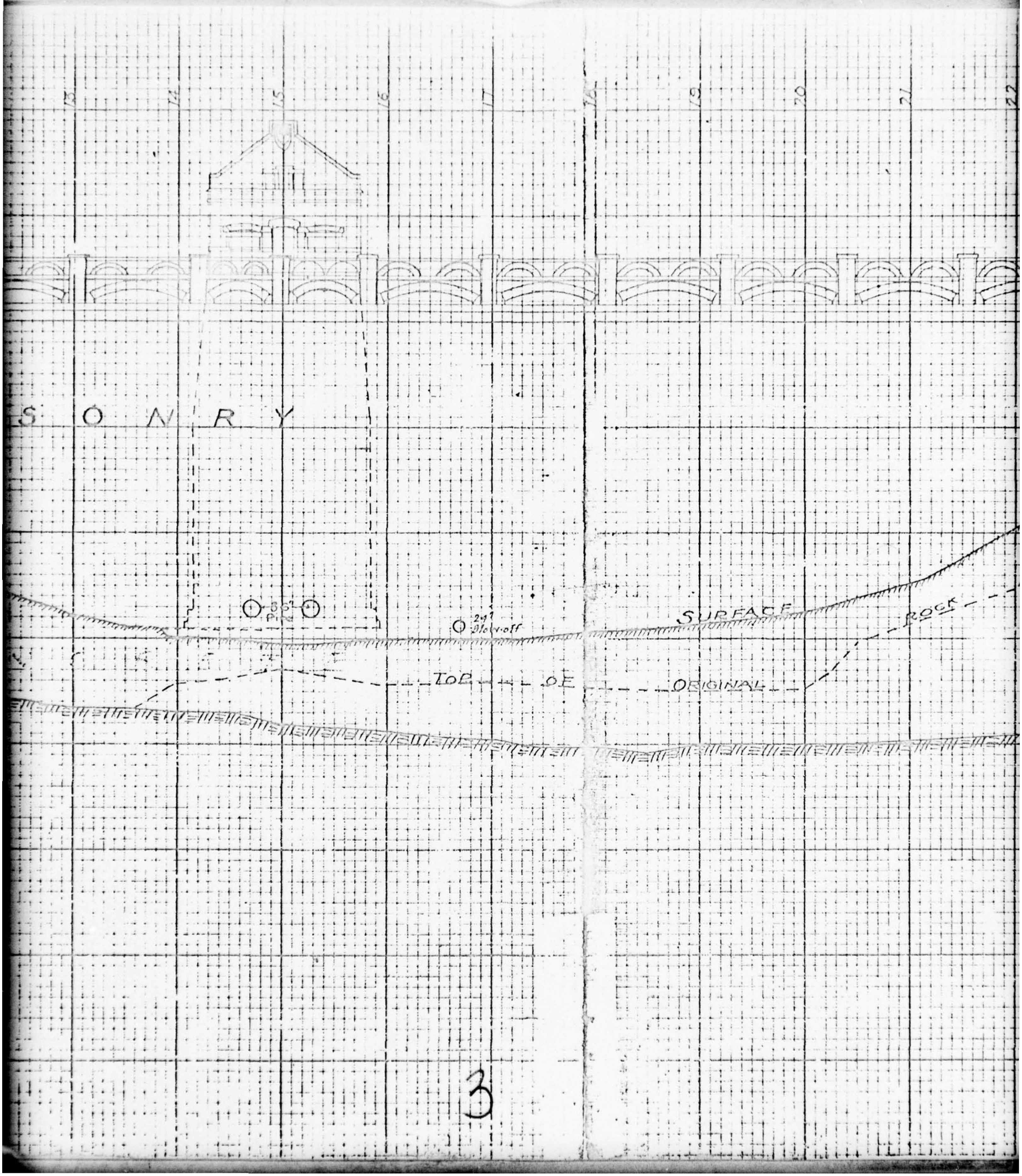
LAKE SCRANTON

SECTION THROUGH CENTER LINE OF DA

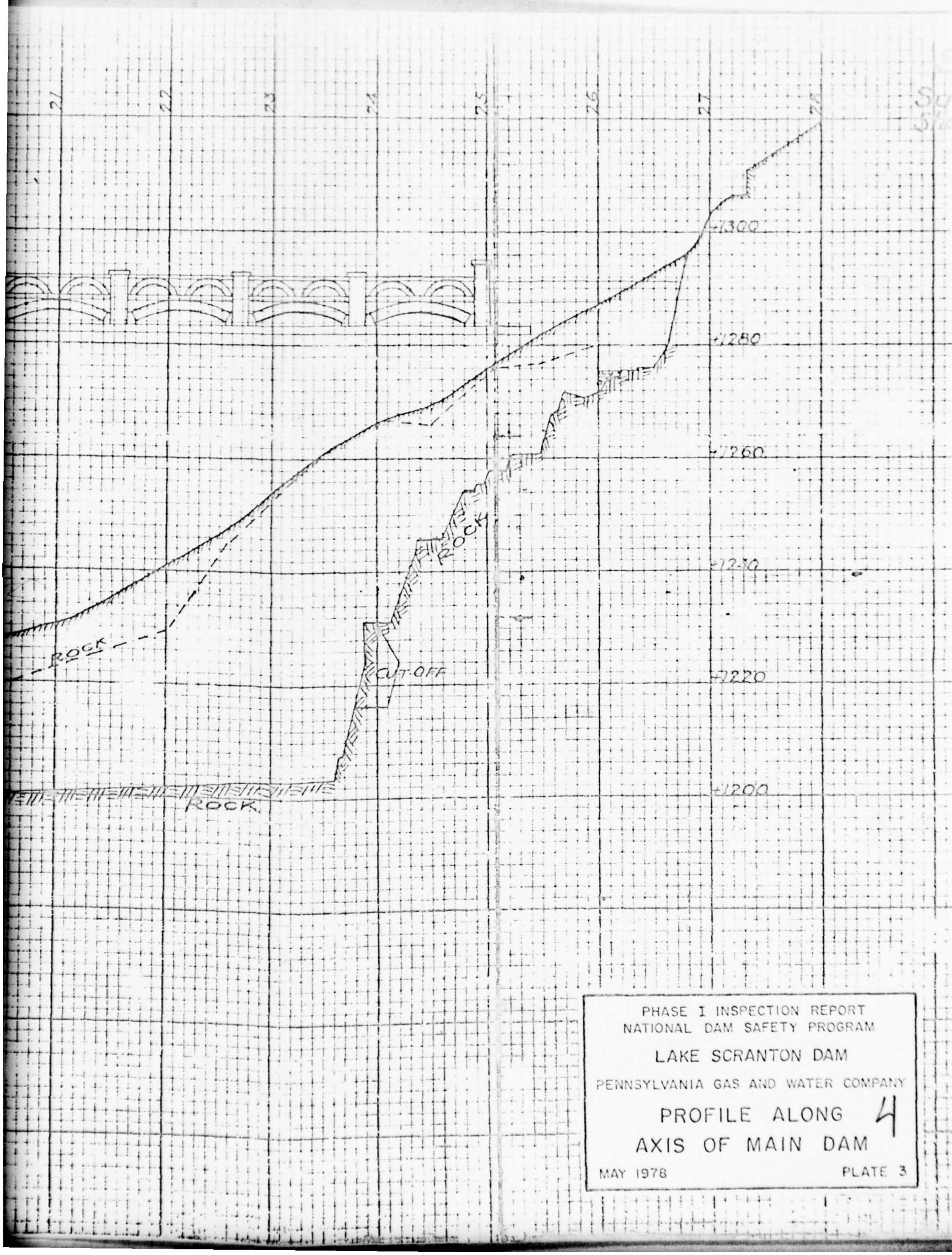
Scale: 1 inch = 20 feet



4
5
6
7
8
9
10
11
12
13
ROAD SURFACE
TOP OF CORE WALL
ORIGINAL
MASO
ROCK



13
14
15
16
17
18
19
20
21
22
SONRY
36" Pipe
24" Blow-off
SURFACE
ROCK
TOP OF ORIGINAL
3



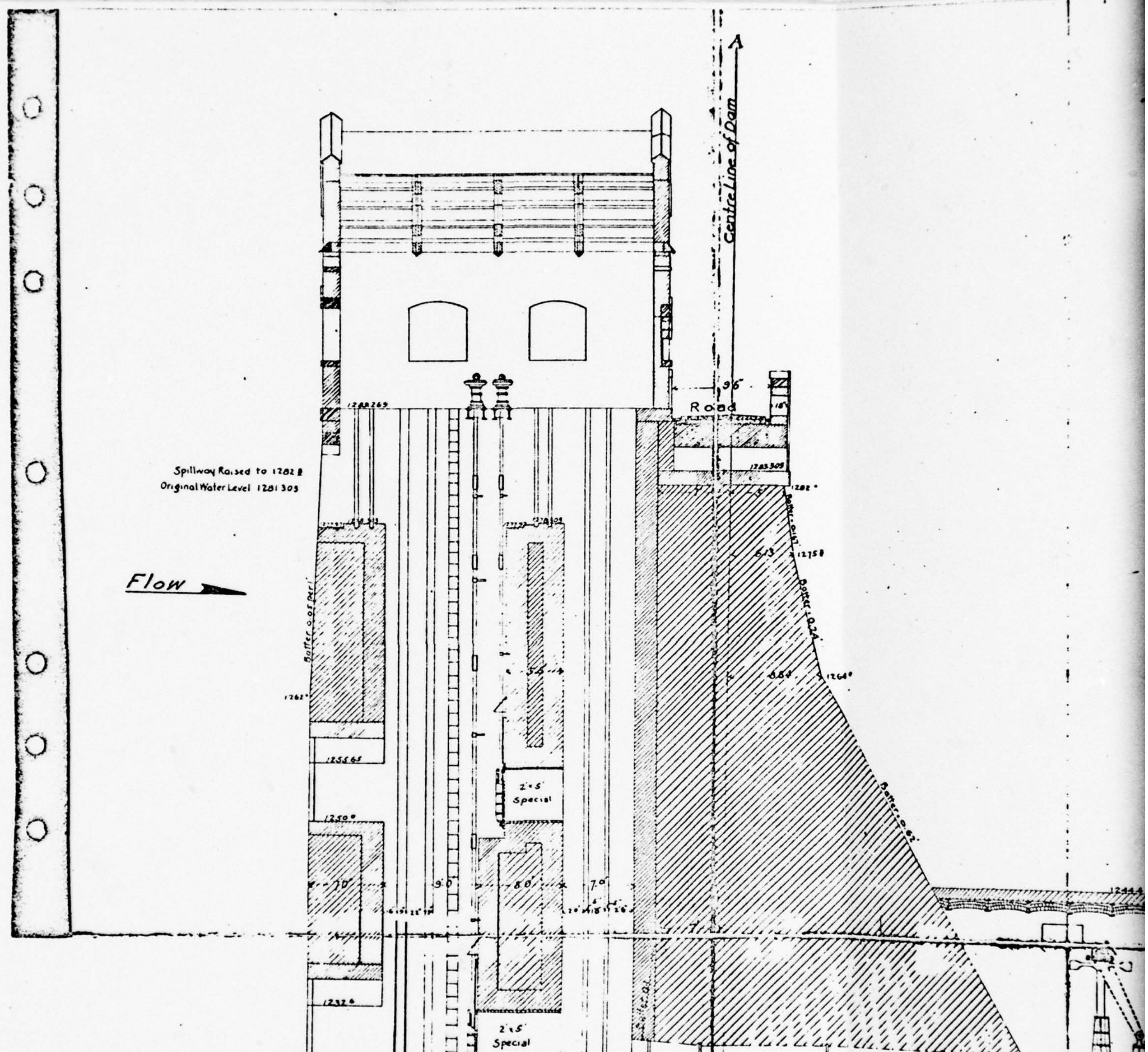
PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY

PROFILE ALONG
AXIS OF MAIN DAM 4

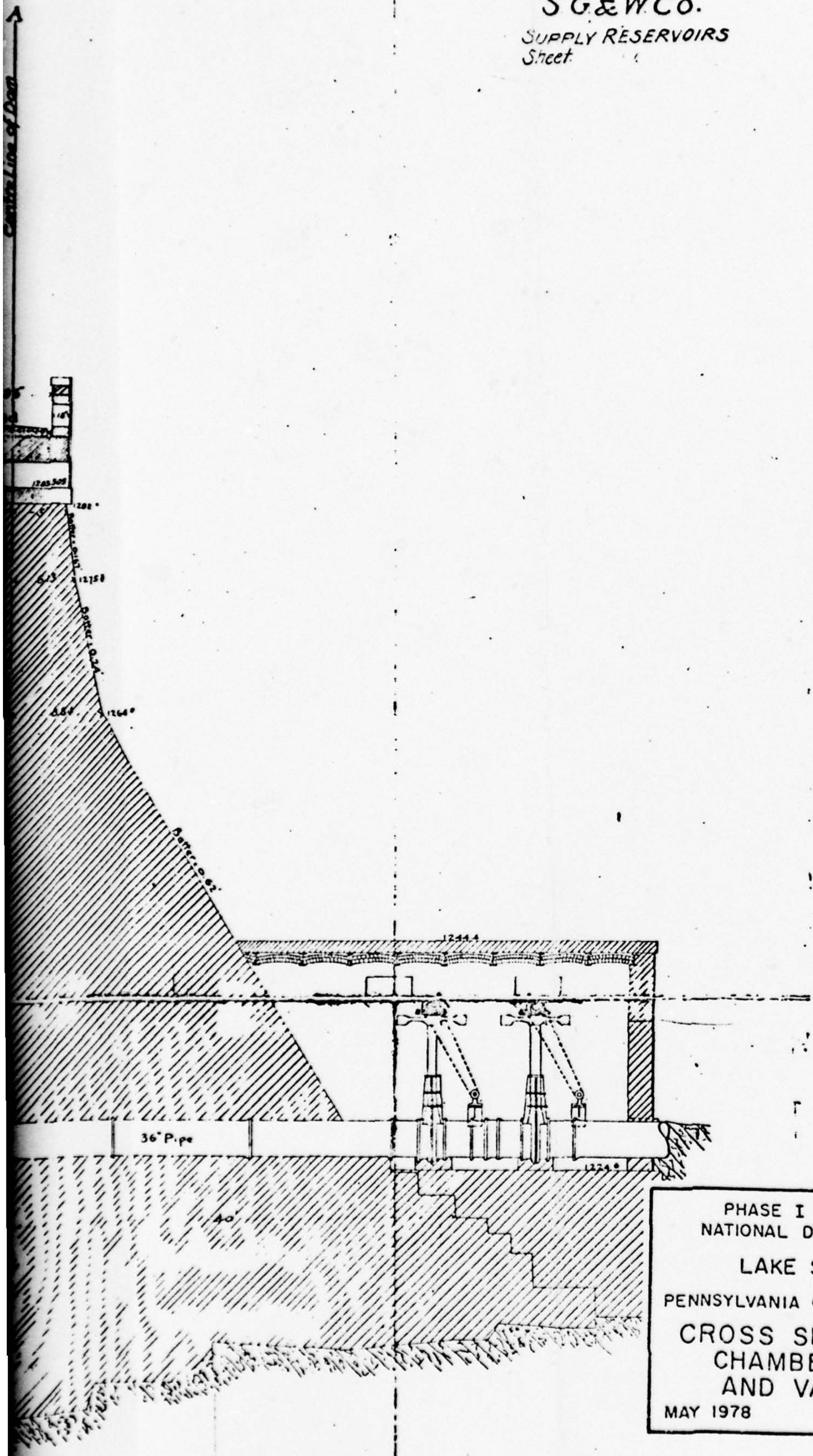
MAY 1978 PLATE 3



LAKE SCRANTON
SECTION A-A THROUGH SCREEN
CHAMBER AND VALVE HOUSE.
Scale ⅛ inch = 1 foot.

1

S G & W Co.
SUPPLY RESERVOIRS
Sheet



2

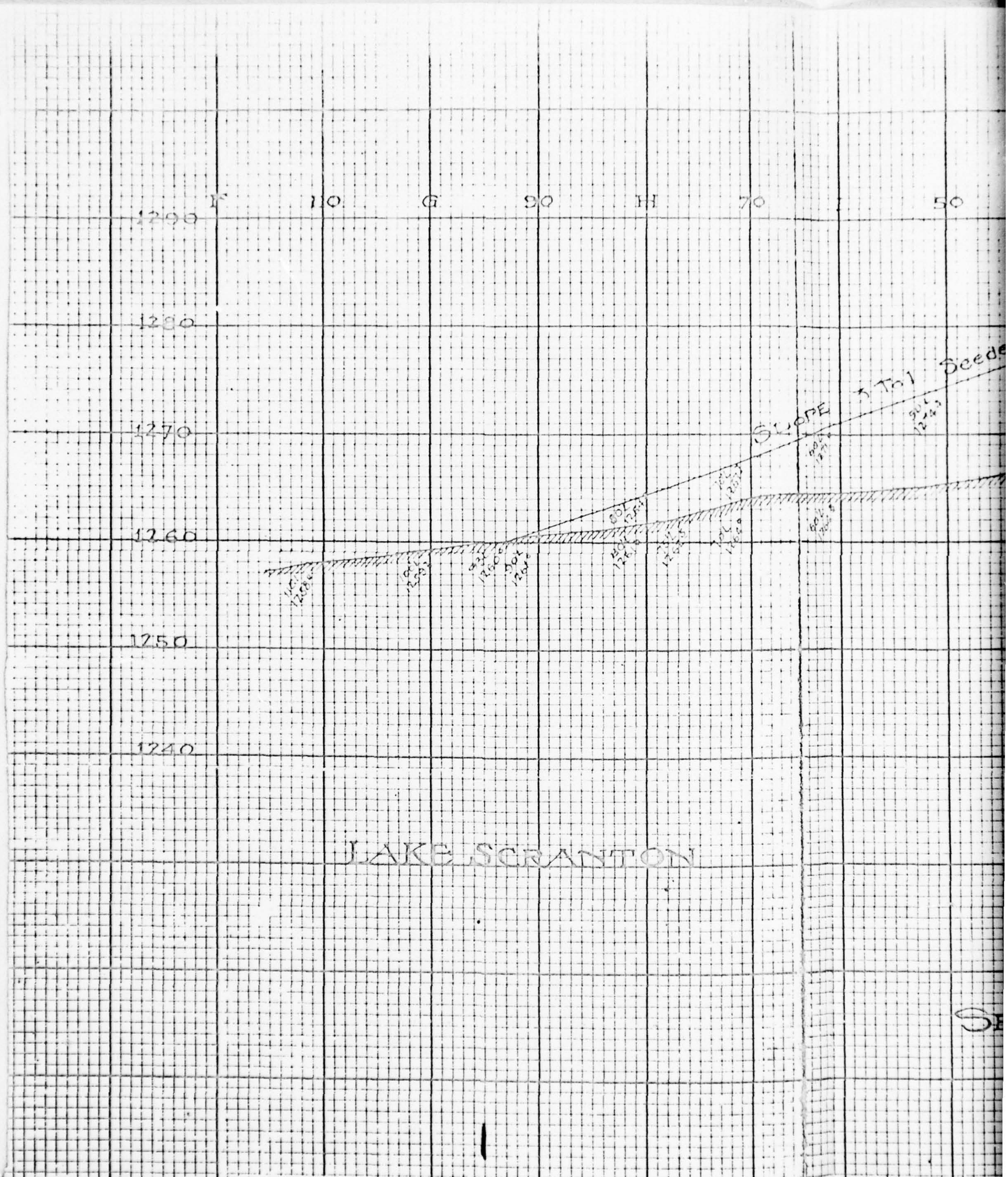
PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

LAKE SCRANTON DAM

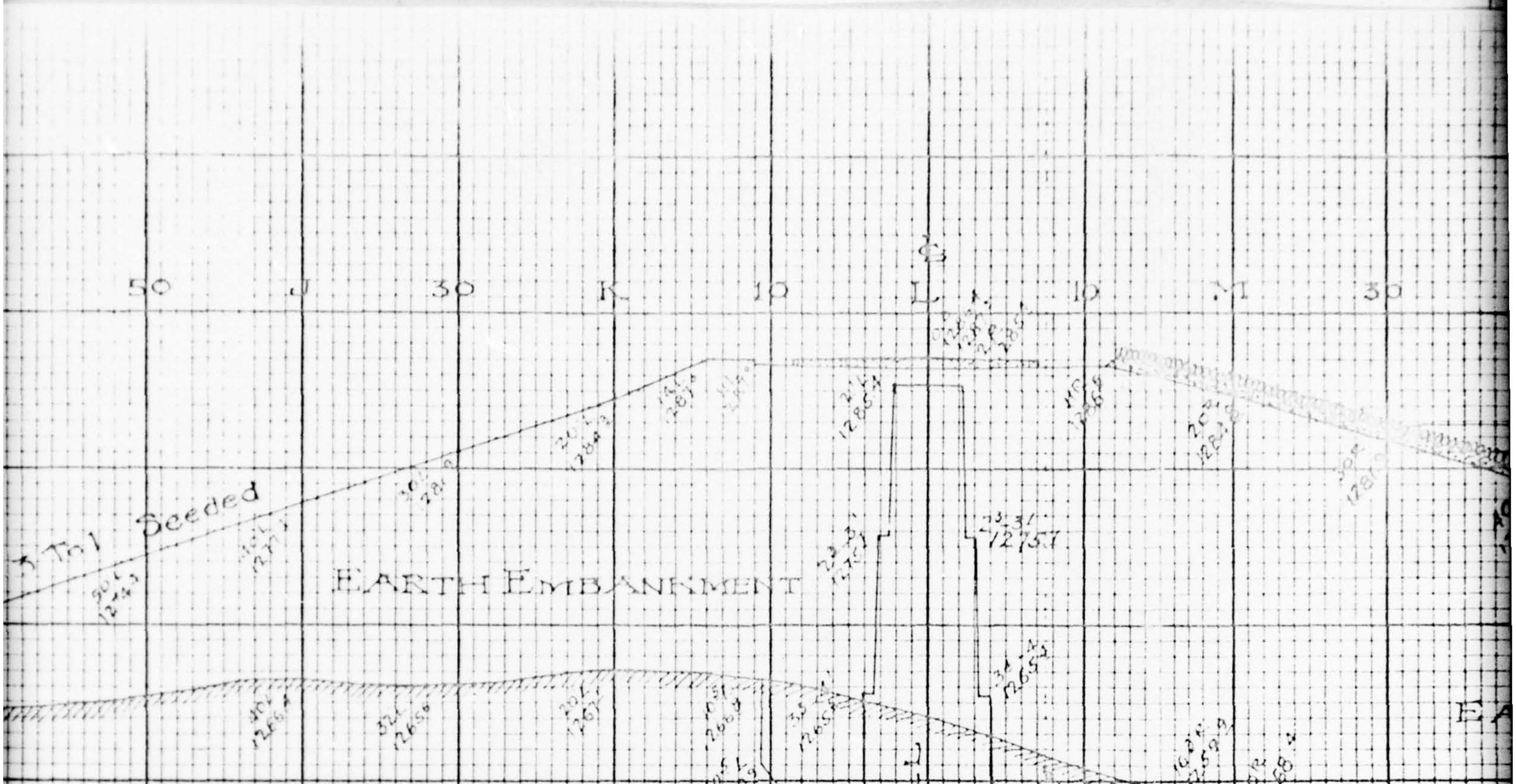
PENNSYLVANIA GAS AND WATER COMPANY

CROSS SECTION-SCREEN CHAMBER, MAIN DAM, AND VALVE HOUSE

MAY 1978 PLATE 4



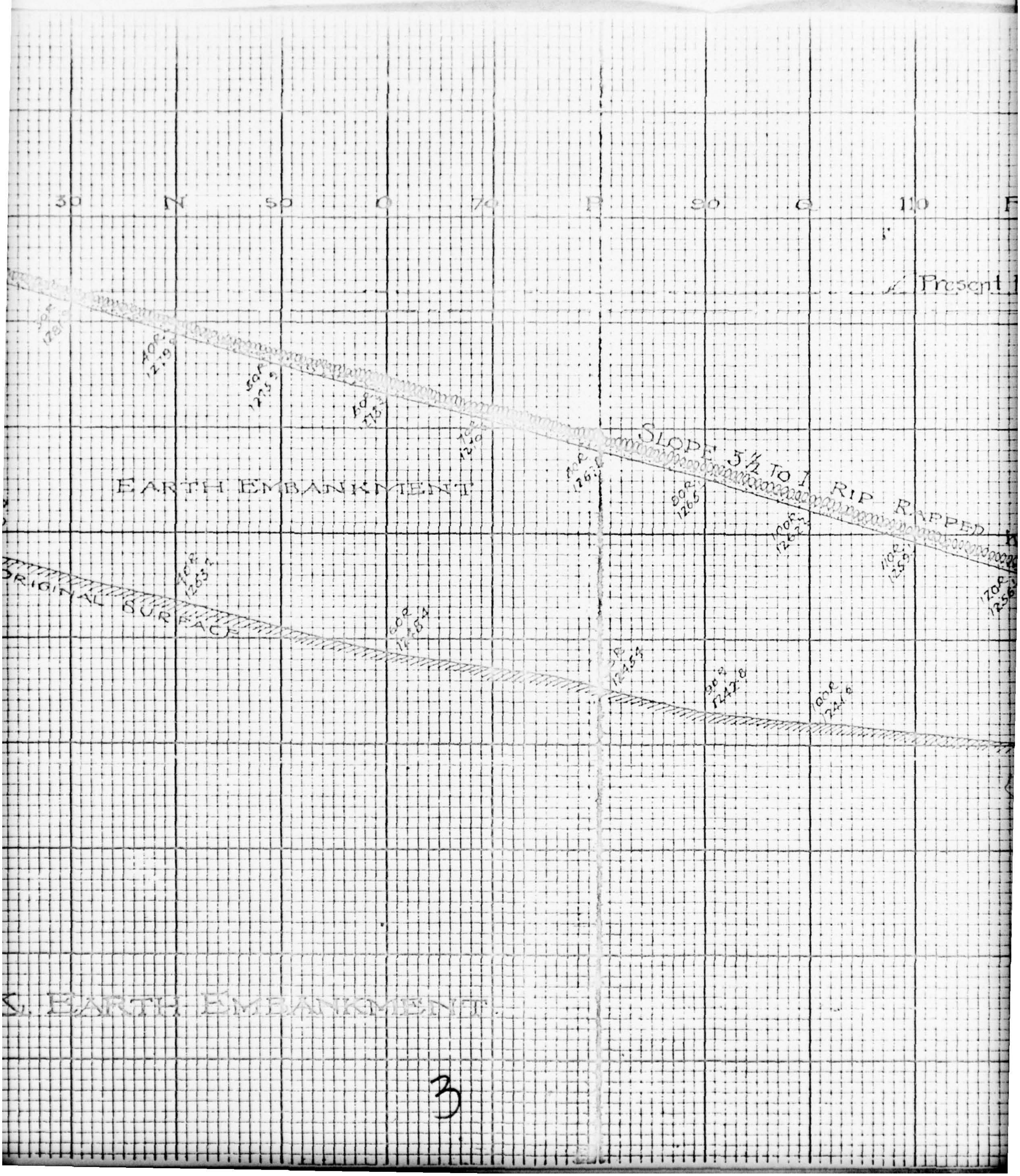
F
110
G
90
H
70
50
1290
1280
1270
1260
1250
1240
SLOPE 3 TO 1 SEEDE
LAKE SCRANTON

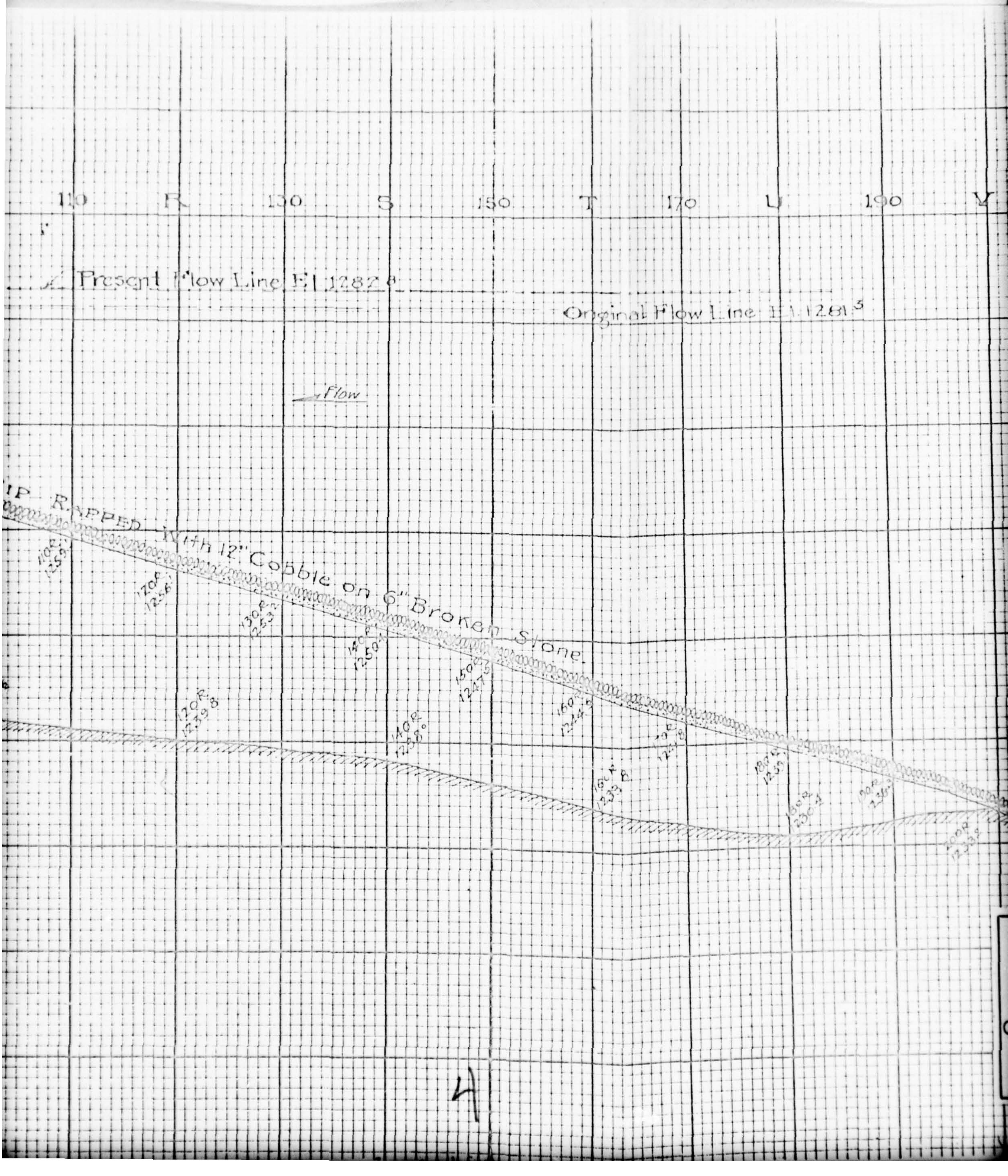


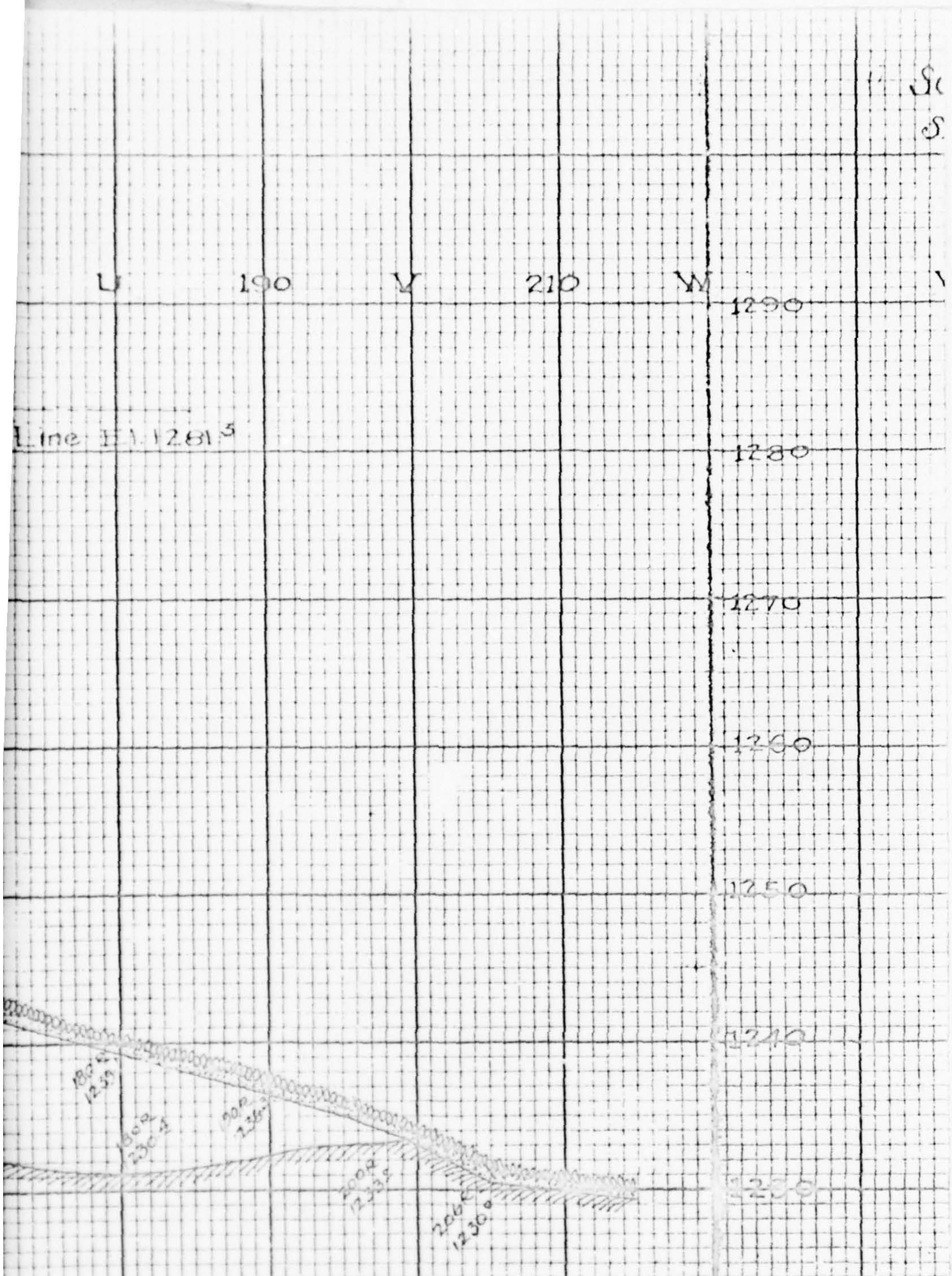
SECTION 6. Through MASONRY CORE WALL & EART

Scales 1" = 10'

2


30
N
50
O
70
P
90
Q
110
Present
SLOPE 5½ TO 1 RIP RAPPED
EARTH EMBANKMENT
ORIGINAL SURFACE
EARTH EMBANKMENT


110
R
130
S
150
T
170
U
190
V
Present Flow Line El 1282.8
Original Flow Line El 1281.5
Flow
RIP RAPPED With 12" Cobble on 6" Broken Stone



PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

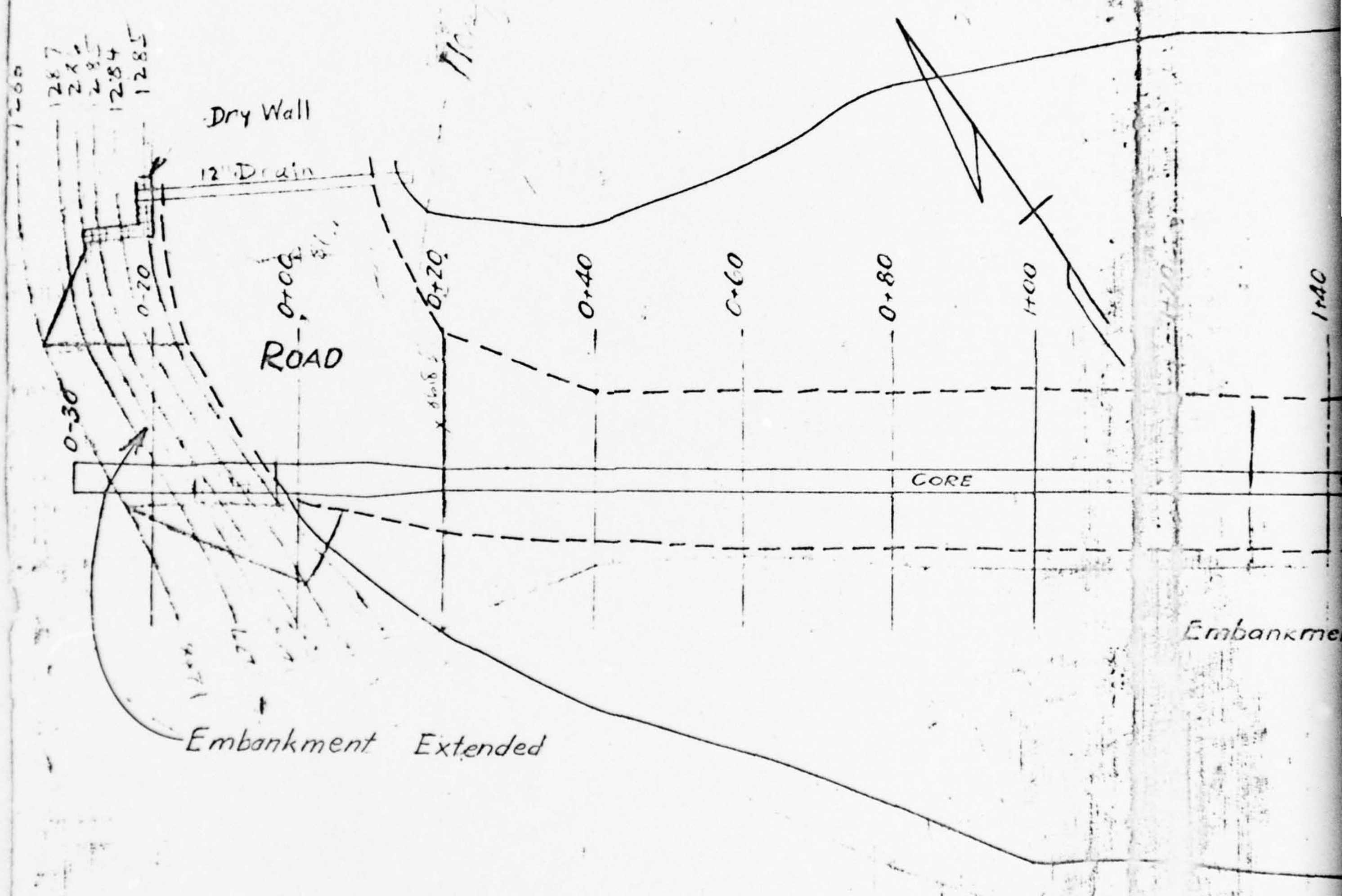
LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY

CROSS SECTION-EMBANKMENT PORTION OF MAIN DAM

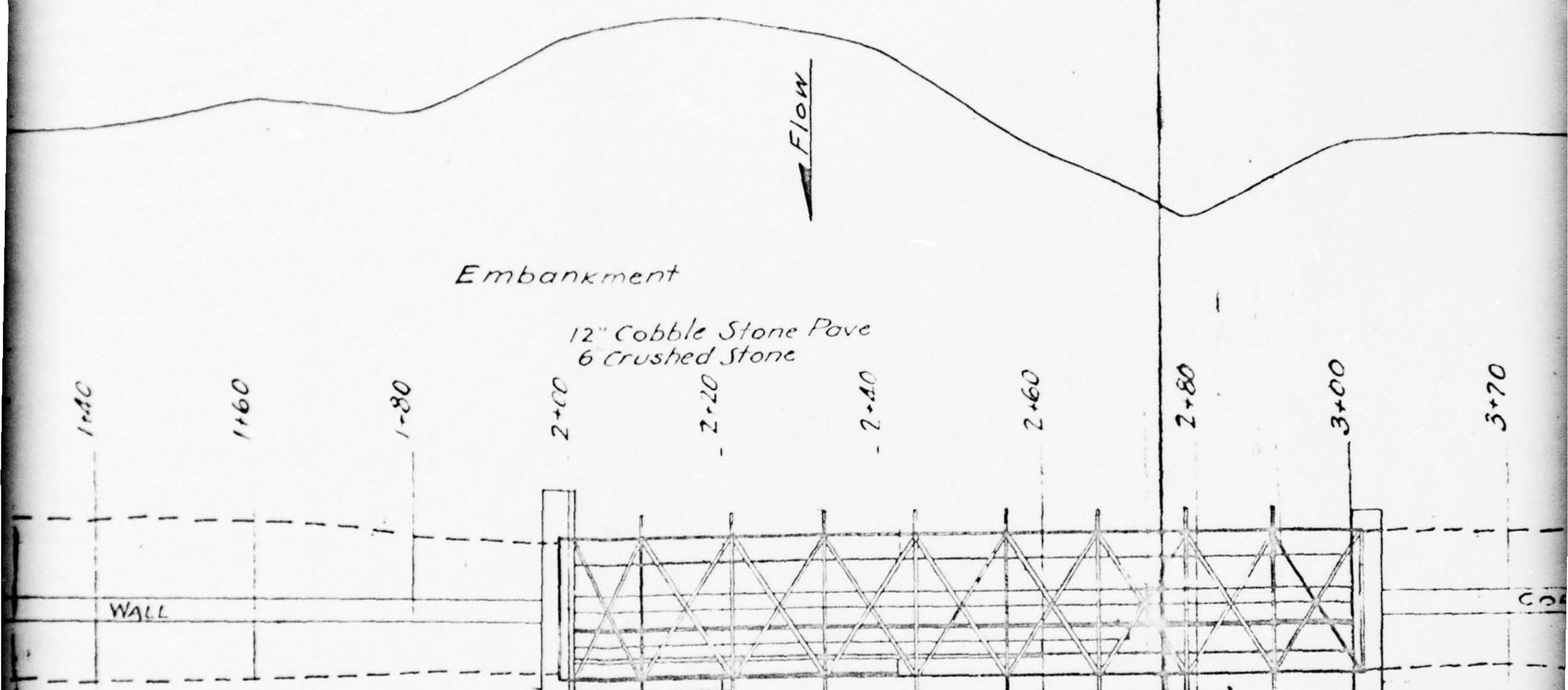
MAY 1978 PLATE 5

5

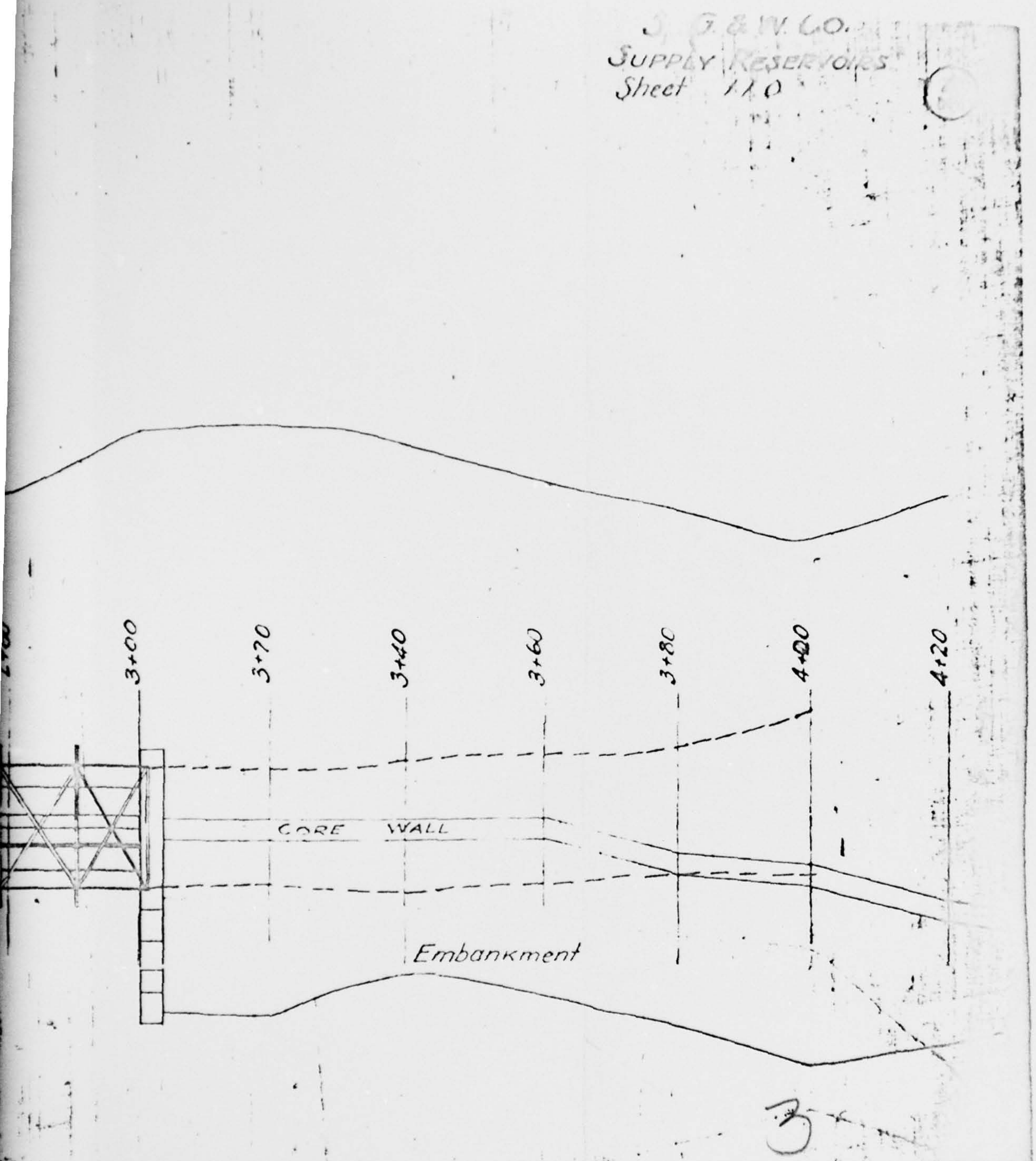


LAKE SCRANTON
LAYOUT OF SPILLWAY DAM
Scale 1 inch = 20 feet

1


Flow
Embankment
12" Cobble Stone Pave
6 Crushed Stone
1+40
1+60
1+80
2+00
2+20
2+40
2+60
2+80
3+00
3+70
WALL
ankment

2



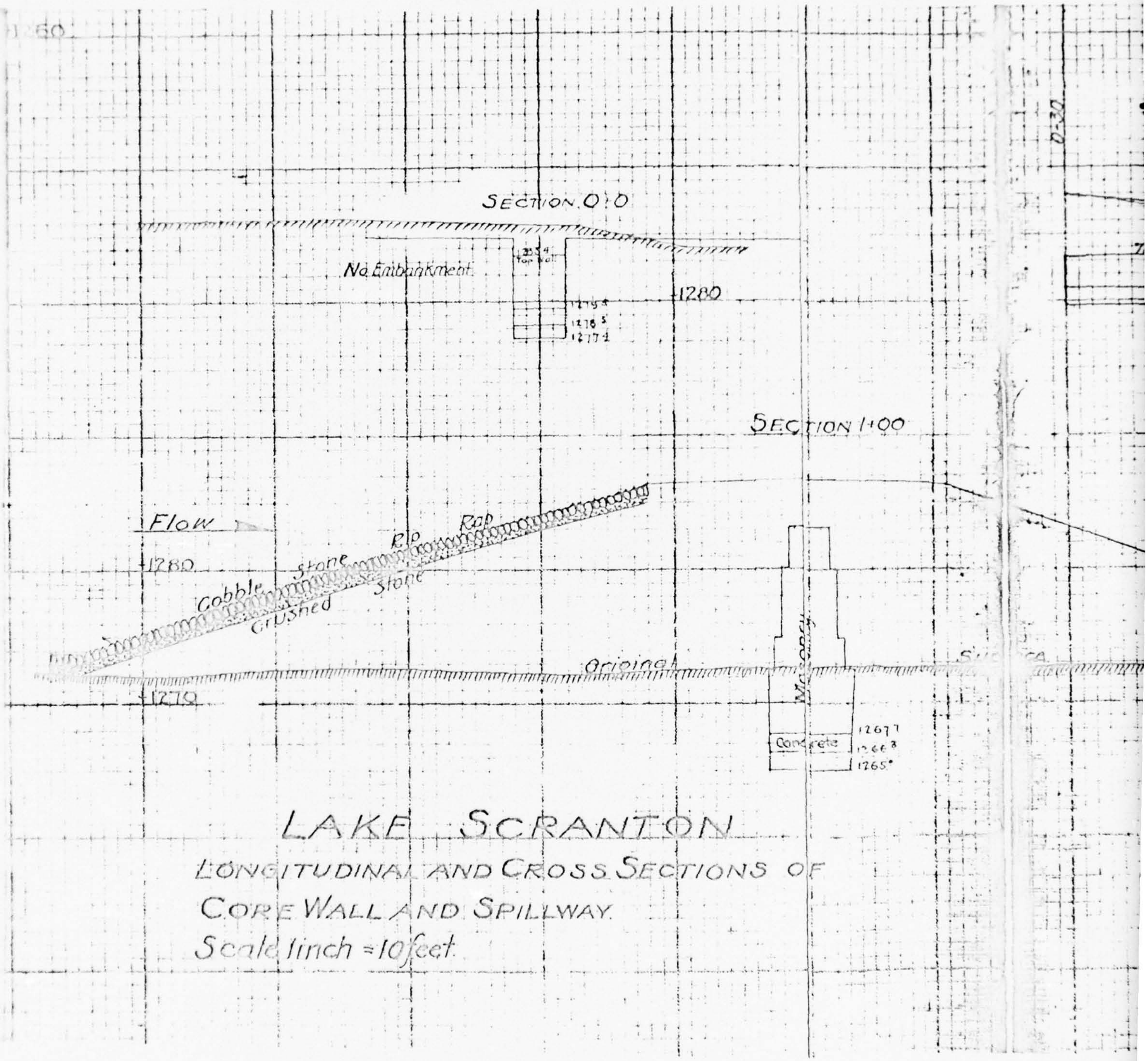
PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

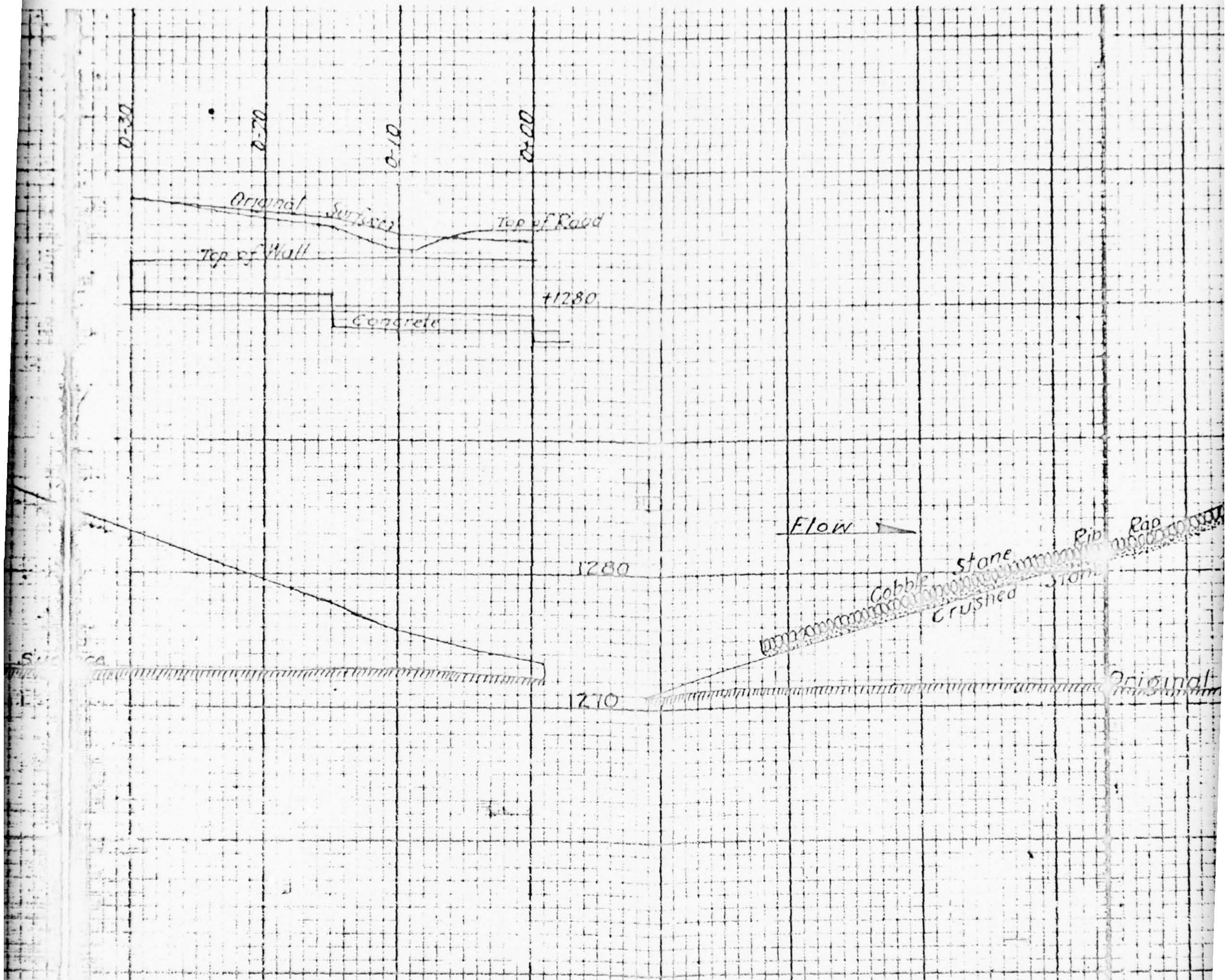
LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY

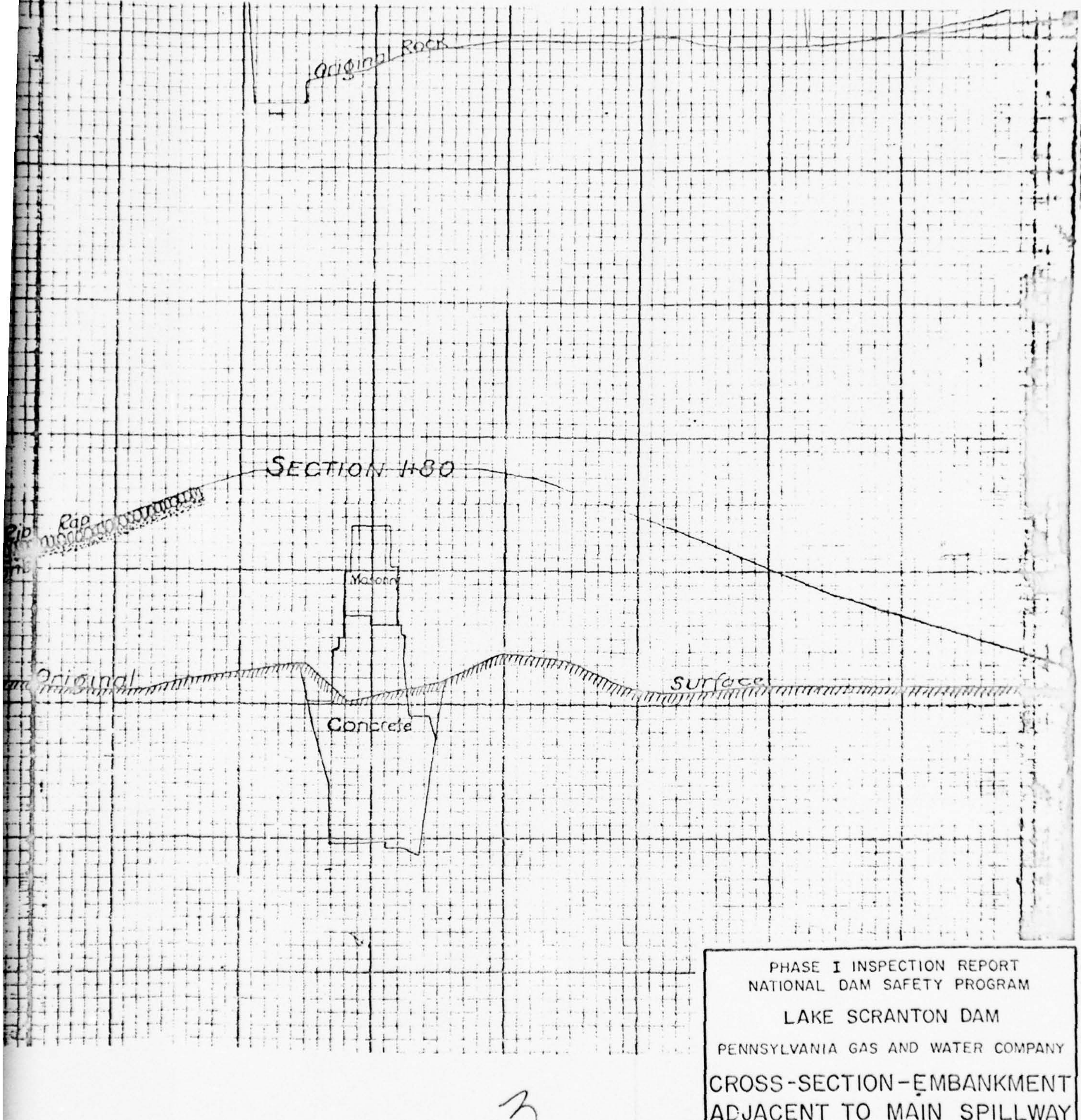
PLAN OF MAIN SPILLWAY AND EMBANKMENT DAM

MAY 1978 PLATE 6


1260
SECTION 0+00
No Embankment
1280
SECTION 1+00
Flow
1280
Cobble Stone Rip Rap
Crushed Stone
Original
Masonry
Concrete
1270
LAKE SCRANTON
LONGITUDINAL AND CROSS SECTIONS OF
CORE WALL AND SPILLWAY.
Scale 1 inch = 10 feet.


0-30
0-20
0-10
0+00
Original Surface
Top of Road
Top of Wall
+1280
Concrete
Flow
Rip Rap
Stone
Cobble
Crushed
Ston
1280
1270
Surface
Original

2



3

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY

CROSS-SECTION-EMBANKMENT ADJACENT TO MAIN SPILLWAY

MAY 1978

PLATE 7

SUSQUEHANNA RIVER BASIN

STAFFORD MEADOW BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1978

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: Lake Scranton

NDS ID NO.: 374 DER ID NO.: 35-21

ITEM	REMARKS
AS-BUILT DRAWINGS	Construction drawings of original structures and subsequent spillway modification.
REGIONAL VICINITY MAP	Project is shown on Scranton, PA-Quadrangle Sheet N 4122.5 - W 7537.5/7.5, 1946, Photorevised 1969; and Olyphant, PA-Quadrangle Sheet N 4122.5 - W 7530/7.5, 1946, Photorevised 1969.
CONSTRUCTION HISTORY	Constructed 1898 by Scranton Gas and Water Company. Modified 1900 and 1916.
TYPICAL SECTIONS OF DAM	Available.
OUTLETS: Plan Details Constraints Discharge Ratings	Plans, sections, and details available. No discharge ratings.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	None
DESIGN REPORTS	Permit application report for proposed 1916 spillway modification.
GEOLOGY REPORTS	1914 report on history and design, has general geologic description.
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	1914 hydraulic and stability analysis of dam and spillway. Stability analysis for 1916 proposed spillway modification.
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	None
POSTCONSTRUCTION SURVEYS OF DAM	None

ITEM	REMARKS
BORROW SOURCES	Materials obtained from onsite. Embankment material is clay with sand. Stone masonry is sandstone and conglomerate.
MONITORING SYSTEMS	Caretakers visit dam daily to check equipment and note water level.
MODIFICATIONS	1900 - Main spillway raised 1.5 feet. 1916 - 1.5-foot masonry coping on main spillway replaced with concrete; added concrete on downstream face of main spillway (final shape was ogee type spillway).
HIGH POOL RECORDS	None
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	1914 evaluation of hydraulics and stability for main spillway and gravity dam.
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	1928 (approx.) - cracking and bulging of retaining wall at left side of gravity dam.

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	No detailed operation records.
SPILLWAY: Plan Sections Details	Sections and details of original structure and subsequent modifications.
OPERATING EQUIPMENT: Plans Details	Plans and details available.
PREVIOUS INSPECTIONS Dates Deficiencies	1921 - general seepage through gravity dam; small leak @ left abutment spillway; brush on downstream face. 1925 - same as 1921. 1928 - same as 1925 plus cracking, seepage, and displacement of retaining wall @ left side of dam. 1930 - no deficiencies noted. 1933 - seepage through spillway and @ left abutment of spillway. 1937 - scaling of spillway concrete. 1941 - same as 1937 plus seepage through dam; seepage @ left abutment spillway.
	1945 - same as 1941 plus seepage @ downstream toe of embankment left of spillway. 1953 - retaining wall @ left side dam cracked and bulging for 30' - 40'.

ENGINEERING DATA

ITEM	REMARKS
PREVIOUS INSPECTIONS (cont'd from Sheet 4)	1957 - same as 1953. 1965 - spillway concrete spalled.

CHECKLIST

ENGINEERING DATA

HYDROLOGY AND HYDRAULICS

NAME OF DAM: Lake Scranton NDS ID NO.: 374 DER ID NO.: 35-21

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): Elevation 1282.8

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Elevation 1286.1

ELEVATION MAXIMUM DESIGN POOL: Elevation 1286.1

ELEVATION TOP DAM: Elevation 1286.1

SPILLWAY CREST:
- a. Elevation Main - Elevation 1282.8; Auxiliary - Elevation 1283.3
- b. Type Main - Concrete Ogee; Auxiliary - 11 Masonry Arches (broad-crested)
- c. Width Main - Not Applicable; Auxiliary 12'
- d. Length Main - 100'; Auxiliary - 17' each for 11 openings
- e. Location Spillover Main - Near left abutment of embankment; Auxiliary - over dam
- f. Number and Type of Gates None

OUTLET WORKS:
- a. Type 36" blowoff; 24" blowoff; and 8-, 30-, and 36-inch water supply
- b. Location Near center of masonry section of main dam and pavilion gatehouse
- c. Entrance Inverts 1227.0 at main dam and 1247.2 at pavilion gatehouse
- d. Exit Inverts About 1220 for blowoffs
- e. Emergency Draindown Facilities 36" and 24" pipes

HYDROMETEOROLOGICAL GAGES:
- a. Type None
- b. Location None
- c. Records None

MAXIMUM NONDAMAGING DISCHARGE: Unknown

SUSQUEHANNA RIVER BASIN

STAFFORD MEADOW BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1978

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Lake Scranton County: Lackawanna State: Pennsylvania

NDS ID No.: 374 DER ID No.: 35-21

Type of Dam: Earth/Masonry Gravity Hazard Category: High

Date(s) Inspection: 4/12/78 Weather: Clear, Windy Temperature: 50° F.

General soil condition - moist

Pool Elevation at Time of Inspection: El 1281.2 msl/Tailwater at Time of Inspection: none msl

Inspection Personnel:

D. Wilson (GFCC)	W. Seip (GFCC)	W. McDonnell (DER)
D. Ebersole (GFCC)	D. Kaufman (PG & W)	
J. Crouse (GFCC)	L. Insalaco (DER)	

D. Wilson (GFCC) Recorder

EMBANKMENT (Adjacent to Main Spillway)

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Two local high areas along toe right of spillway.	Not abnormally wet or soft; could be normal irregularities.
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	Slight sloughing of upstream slope adjacent to both sides spillway where riprap has been lost.	Not serious.
CREST ALIGNMENT: Vertical Horizontal	No abnormalities.	
RIPRAP FAILURES	Loss of riprap at both abutments of spillway. Otherwise intact.	Owner says people using hiking path throw riprap into lake; this was observed and verified during inspection.

EMBANKMENT (Adjacent to Main Spillway)

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	No abnormalities.	
ANY NOTICEABLE SEEPAGE	None.	
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	
TREES AND SHRUBS	Four small shrubs growing on upstream face. Heavy forest begins about 10 feet from toe embankment. Two 4-inch trees on downstream face left of spillway.	

CONCRETE/MASONRY DAMS

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Downstream face near right abutment about 10' below crest-face wet. Several damp spots over downstream face.	No severe seepage. All seepage points at less than 1 gpm. No damage to other features is resulting.
JUNCTION OF STRUCTURE WITH: Abutment Embankment Other Features	No abnormalities.	
DRAINS	Drain along retaining wall @ left side gravity dam.	Owner says drain installed at time of wall repair. Consists of gravel layer with pipe. Discharges into drywell @ end of wall.
WATER PASSAGES	None.	
FOUNDATION	Sandstone outcrops @ right abutment. No evidence of foundation problems.	

CONCRETE/MASONRY DAMS

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES: Surface Cracks Spalling	No concrete.	
STRUCTURAL CRACKING	None.	
ALIGNMENT: Vertical Horizontal	No irregularities.	
MONOLITH JOINTS	Masonry joints on downstream face sound; upstream face submerged.	
CONSTRUCTION JOINTS	Masonry excellent.	
STAFF GAGE OR RECORDER	None.	

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Intake structure masonry above pool elevation in good condition.	Slots provided downstream of trashrack, but no bulkheads available. Bulkhead required only when pool elevation about 1278.30.
INTAKE STRUCTURE	Masonry in good condition. Upper left trashrack bars broken. Chain hoist and trolley beam coated with rust.	To prevent flow through low level conduits.
OUTLET STRUCTURE	Water in gate houses 2 inches deep but could not find source	
OUTLET CHANNEL	Channel is clear unobstructed varying slope streambed.	
EMERGENCY GATE	Two men opened 24-inch discharge valve 6 inches in 20 minutes. Two men opened 36 - inch discharge valve 4 inches in 40 minutes.	

UNGATED SPILLWAY (Main Spillway)

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Very severe scaling over 2/3 of downstream face to maximum depth of 7 inches. Steel reinforcement exposed and corroded on 1 monolith - Severe horizontal cracking @ construction joints.	See "Seepage" below; ability to withstand great floods questionable.
APPROACH CHANNEL	Clear, no constraints except bridge.	
DISCHARGE CHANNEL	Normally dry; heavy woods starts above 100 feet downstream.	
BRIDGE AND PIERS	Access road bridge over crest; good condition; low steel is about 2.5 feet above crest level.	
SEEPAGE	Estimated 2-3 gpm leakage through construction joint near crest @ left and; joint weathered to maximum depth of 10 inches; less leakage at other locations.	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	2 Piezometers on upstream face embankment just upstream spillway; installed, 1916.	Both inoperative.
OTHER	None.	

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Mild to steep with some vertical rock outscrops; no evidence of land slides, rock slides, or creep; all slopes wooded.	
SEDIMENTATION	No sediment problem reported by owner.	
WATERSHED DESCRIPTION	Wooded, hilly, partially controlled.	Williams Bridge Dam located about 1/4 mile upstream.

DOWNSTREAM CHANNEL (Below Dam)

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	Dry bed; irregular cross-section; wooded area begins about 300 feet downstream of dam.	
SLOPES	No evidence of erosion or instability.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	City of Scranton about 5 miles downstream.	
PROPANE TANK	A tank was observed below dam. Owner thought it was propane.	Tank is in potentially hazardous location with respect to vandalism and flow over dam.

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
EMBANKMENT ADJACENT TO GRAVITY DAM	Upstream slope - some loss of riprap adjacent to dam. Downstream slope - uneven, average slope is 1 v on 3 h; seepage @ toe embankment over	Owner says riprap loss caused by people throwing stone into lake or over dam.
	about 20 foot square area adjacent to retaining wall.	Owner says seepage area is same as location of drywell that receives retaining wall drainage. Seepage does no damage to other features.
RETAINING WALL ADJACENT TO DAM	Cracked and displaced wall repaired in 1977 by excavating, installing drain, and rebuilding.	Slight seepage from base of wall close to seepage area behind wall.

SUSQUEHANNA RIVER BASIN

STAFFORD MEADOW BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1978

APPENDIX C

HYDROLOGY AND HYDRAULICS

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT: LAKE SCRANTON DAM (35-21) — HYDROLOGY AND HYDRAULICS ANALYSIS
FILE NO. 7613.10
SHEET NO. 1 OF 10 SHEETS
FOR: USCE - BALTIMORE DISTRICT
COMPUTED BY: JMC DATE: 5/5/78 CHECKED BY: [illegible] DATE: 5/8

CLASSIFICATION

HIGH HAZARD, SINCE POPULATION DOWNSTREAM IS 103,564

INTERMEDIATE SIZE, SINCE HEIGHT = 60 FEET AND CAPACITY = 2,518 MILLION GALLONS
REFERENCE: "RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS," p. D-3

SPILLWAY DESIGN FLOOD (SDF)
THE SDF SHOULD BE THE PMF (FROM p. D-12 OF "REC. GUIDELINES ...")

HYDROLOGY AND HYDRAULICS ANALYSIS
REFERENCE: PHASE I PROCEDURE PACKAGE

II. A. 1. THE PMF INFLOW HYDROGRAPH PEAK FOR WILLIAMS BRIDGE (JUST UPSTREAM) IS AVAILABLE FROM THE OWNER (PG&W) OF THE DAM. TRANSPOSE THE PMF PEAK TO LAKE SCRANTON. FROM A 1972 STUDY BY JUSTIN & COURTNEY OF PHILADELPHIA, THE PMF PEAK FOR WILLIAMS BRIDGE IS 17,000 CFS.

GENERALIZED FORM OF TRANSPOSITION (REFERENCE: BALTIMORE CONTACT - MIKE KANOWITZ)

$$\frac{Q_1}{Q_2} = \left(\frac{D.A._1}{D.A._2}\right)^{0.8}$$

$$\text{OR,} \quad Q_1 = Q_2 (D.A._1 / D.A._2)^{0.8}$$

$$Q_1 = 17{,}000 (6.0 / 5.0)^{0.8}$$

$$Q_1 = 19{,}670 \text{ CFS}$$

$\therefore X = 19{,}670$ CFS = PMF PEAK FOR STORM OVER ENTIRE LAKE SCRANTON WATERSHED

EFFECT OF UPSTREAM RESERVOIR

DO NOT NEGLECT EFFECT OF WILLIAMS BRIDGE RESERVOIR
PROPORTION OF LAKE SCRANTON PMF PEAK AT WILLIAMS BRIDGE RESERVOIR

$$\frac{\text{WILLIAMS BRIDGE COMPONENT PMF PEAK}}{\text{WILLIAMS BRIDGE DRAINAGE AREA}} = \frac{\text{TOTAL PMF PEAK AT LAKE SCRANTON}}{\text{TOTAL D.A. AT LAKE SCRANTON}}$$

$$\frac{Y}{5.0} = \frac{19{,}670}{6.0}$$

$\therefore Y = 16{,}390$ CFS = WILLIAMS BRIDGE COMPONENT OF LAKE SCRANTON PMF PEAK

8313

PMF PEAK INFLOW FROM STORM OVER WILLIAMS BRIDGE WATERSHED ALONE

FROM WILLIAMS BRIDGE PHASE I INSPECTION REPORT, PMF PEAK FOR WILLIAMS BRIDGE WATERSHED = 17,000 CFS.

a. DESIGN CALCULATIONS ARE NOT AVAILABLE

c. THE HYDROGRAPH IS INADEQUATE, SINCE ONLY PEAK IS AVAILABLE

2. PMF INFLOW HYDROGRAPH IS INADEQUATE

b. OBTAIN TOTAL TIME FROM THE PHASE I PROCEDURE PACKAGE GRAPH OF TOTAL TIME VS. D.A. FOR THE SUSQUEHANNA RIVER BASIN

B. ABILITY OF SPILLWAY TO PASS PMF

1. CAPACITY OF SPILLWAY

IN 1915, THE TOTAL SPILLWAY CAPACITY WAS ESTIMATED TO BE 2,300 CFS FOR A HEAD OF 2.5 FEET ON THE MAIN SPILLWAY. SINCE THEN, THE SHAPE OF THE CREST OF THE MAIN SPILLWAY HAS BEEN IMPROVED TO APPROXIMATE AN OGEE-SHAPE. ALSO, THE LOW POINT OF THE TOP OF DAM HAS BEEN ESTABLISHED AT 1286.1', SO THAT A HEAD OF (1286.1 - 1282.8) = 3.3 FEET MAY BE OBTAINED BEFORE THE DAM IS OVERTOPPED.

MAIN SPILLWAY

GIVEN: MAXIMUM POOL ELEVATION BEFORE OVERTOPPING AT ELEVATION 1286.1'
LOW STEEL ON BRIDGE OVER MAIN SPILLWAY AT ELEVATION 1285.3'
OGEE-SHAPED SPILLWAY
SPILLWAY CREST AT ELEVATION 1282.8'
HEIGHT OF SPILLWAY IS 1282.8' - 1270.4' 12.4'
EMBANKMENT SLOPE ON U/S FACE = 3½ H ON 1V

ASSUMPTIONS: CORRECTION FOR "C" FOR EMBANKMENT SLOPE IS NEGLIGIBLE
WEIR FLOW CONTROLS FROM ELEVATION 1282.8' TO 1285.3'
ORIFICE FLOW CONTROLS FROM ELEVATION 1285.3' TO 1286.1'
OGEE CREST WAS DESIGNED FOR POOL ELEVATION 1286.1'

REFERENCES: <u>DESIGN OF SMALL DAMS</u>, USBR, pp 372-385 (WEIR EQUATION)
<u>ELEMENTARY FLUID MECHANICS</u>, VENNARD, p. 426 (ORIFICE EQUATION)

WEIR CONTROL (1282.8 TO 1285.3) $Q = C_o L H_o^{3/2}$

$C_o = fcn(P/H_o)$; $P = 12.4'$, $H_o = (1286.1 - 1282.8) = 3.3'$

$P/H_o = 3.76$, $C_o = 3.95$; C FOR $H \neq H_o$ VARIES

IF SPILLWAY BRIDGE WAS NOT A RESTRICTION, $Q = 3.95(100)(3.3)^{3/2} = 2,368$ CFS

ORIFICE CONTROL (1285.3 TO 1286.1) $Q = CA\sqrt{2gh}$

AT MAXIMUM POOL ELEVATION OF 1286.1,

$h = 1286.1 - \left(\frac{1285.3 + 1282.8}{2}\right) = 2.05'$

$A = (1285.3 - 1282.8)' \times 100' = (2.5')(100') = 250'^2$

USE C = 0.80 FOR SHORT TUBE

$\therefore Q = 0.80(250)\sqrt{2(32.2)\,2.05} = 2{,}298$ CFS

THE CAPACITY OF THE MAIN SPILLWAY IS 2,298 CFS

AUXILIARY SPILLWAY

GIVEN : AUXILIARY SPILLWAY CONSISTS OF 11 ARCHES, EACH WITH A BASE WIDTH OF 17 FEET

ASSUMPTIONS : AUXILIARY SPILLWAY ACTS AS A BROAD-CRESTED WEIR
NO BLOCKING OF ARCHES OCCURS
EFFECTIVE LENGTH OF EACH ARCH DECREASES AS HEAD INCREASES
SPILLWAY CREST ELEVATION = 1283.3'

REFERENCE : ELEMENTARY FLUID MECHANICS, VENNARD, p. 372

BROAD-CRESTED WEIR EQUATION : $q = \sqrt{g(2H/3)^3}$

$\therefore Q = L\sqrt{g(2H/3)^3}$

HEAD ON AUXILIARY SPILLWAY = 1286.1 - 1283.3 = 2.8'

$q = \sqrt{32.2(2(2.8)/3)^3}$

$q = 14.47$

L = 11 × EFFECTIVE LENGTH PER ARCH

L = 11 × 13.7'

L = 151 FEET

$\therefore Q = L(14.47)$

$Q = 151(14.47)$

$Q = 2{,}185$ CFS

THE CAPACITY OF THE AUXILIARY SPILLWAY IS 2,185 CFS (SEE DISCUSSION ON SHEET 4)

∴ THE TOTAL DISCHARGE CAPACITY OF LAKE SCRANTON DAM BEFORE OVERTOPPING

= 2,298 + 2,185

= 4,483 CFS

SAY 4,480 CFS

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT LAKE SCRANTON DAM (35-21) FILE NO. 7613.10
HYDROLOGY AND HYDRAULICS ANALYSIS SHEET NO. 1 OF 10 SHEETS
FOR USCE - BALTIMORE DISTRICT
COMPUTED BY WDC DATE 6/3/78 CHECKED BY ______ DATE ______

DISCUSSION OF AUXILIARY SPILLWAY CAPACITY

THE COMPUTED CAPACITY FOR THE AUXILIARY SPILLWAY IS PROBABLY SLIGHTLY ON THE HIGH SIDE. NO BLOCKAGE OF ARCHES WAS CONSIDERED, AND USING CRITICAL DEPTH OVER A WEIR IS EQUIVALENT TO USING A DISCHARGE COEFFICIENT OF 3.08, WHICH MAY BE A LITTLE HIGH FOR THIS WEIR. A MORE REFINED SOLUTION IS NOT WARRANTED SINCE THE SPILLWAYS (MAIN & AUXILIARY) CAN ONLY PASS 28% OF THE PMF AT MAXIMUM POOL. A MORE CONSERVATIVE DISCHARGE COEFFICIENT OF 2.7 FOR THE AUXILIARY SPILLWAY WOULD ONLY LOWER THE 28% TO ABOUT 26% OF THE PMF.

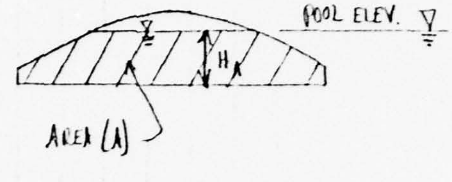
8313

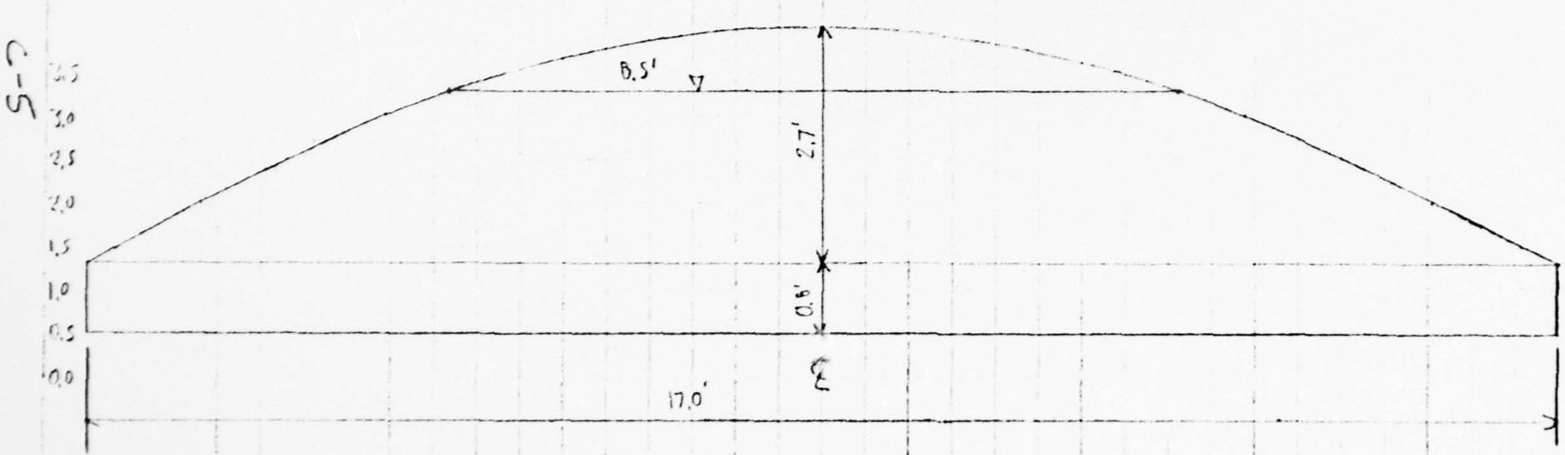
H ON MAIN (FT)	H_A ON AUX. (FT)	TOP WIDTH (FT)	AREA, A (FT^2)	L_E, EFFECTIVE/ARCH (FT)	L_E, EFFECTIVE, TOTAL (FT)
3.3	2.8	8.5	38.4	13.7	151

DEFINITION OF EFFECTIVE LENGTH (L_E)

$$L_e \times H_A = A$$

$$L_e = \frac{A}{H_A}$$





TYPICAL AUXILIARY SPILLWAY ARCH

THE CRITICAL CASE FOR THE LAKE SCRANTON ANALYSIS WILL BE A STORM OVER THE ENTIRE LAKE SCRANTON WATERSHED PMF, SINCE THE PHASE I INSPECTION REPORT FOUND THAT WILLIAMS BRIDGE DAM WOULD BE OVERTOPPED BY THE WILLIAMS BRIDGE PMF OR BY ONE-HALF OF THE WILLIAMS BRIDGE PMF.

II. B. ABILITY OF WILLIAMS BRIDGE SPILLWAY TO PASS WILLIAMS BRIDGE COMPONENT OF LAKE SCRANTON PMF

1. CAPACITY OF WILLIAMS BRIDGE SPILLWAY = 5,560 CFS
3. THE WILLIAMS BRIDGE COMPONENT OF THE LAKE SCRANTON PMF PEAK FLOW IS GREATER THAN THE SPILLWAY CAPACITY (16,390 > 5,560)
   b. ROUTING IS NOT AVAILABLE
      (1.) THE SPILLWAY WILL PASS (5,560/16,390) = 0.339 = p = 33.9% OF THE PEAK
      (2.) INCLUSIVE 3 METHOD TO ESTIMATE STORAGE EFFECT OF RESERVOIR
         (a) TRIANGLE SHAPE FOR PMF HYDROGRAPH
         (b) BASE TIME COMPUTATION - SAY TOTAL TIME (T) = WILLIAMS BRIDGE TIME

T FOR WILLIAMS BRIDGE, D.A. = 5.0 SQ. MI. = 24.5 HOURS

$1-p = 1.0 - 0.339 = 0.661 = \frac{\Delta ADC}{\Delta ADB}$

$\Delta ADB = \frac{1}{2} b h = \frac{1}{2}(24.5)(16,390) = 200,800$ CFS-HRS

$\Delta ADC = (1-p)\,\Delta ADB = (0.661)\,200,800 = 132,710$ CFS-HRS

132,710 CFS-HRS × (3,600 AC-SEC/43,560 FT²-HR) = 10,970 AC-FT

REQUIRED STORAGE = 10,970 AC-FT

         (c) INCREMENTAL STORAGE AVAILABLE BETWEEN NORMAL POOL ELEVATION AND MAXIMUM POOL ELEVATION

FROM PHASE I INSPECTION REPORT FOR WILLIAMS BRIDGE,
INCREMENTAL STORAGE AVAILABLE BETWEEN ELEVATIONS
1366.2' AND 1360.6' WAS 242 AC-FT

FOR LAKE SCRANTON, THE OWNER PROVIDED A RESERVOIR CAPACITY TABLE

AT 1282.8', STORAGE = 0 AC-FT
1286.0', STORAGE = 732 AC-FT
1287.0', STORAGE = 962 AC-FT

INTERPOLATING, STORAGE AT 1286.1' IS 755 AC-FT

STORAGE REQUIRED = 10,970 AC-FT >> STORAGE AVAILABLE = 242 AC-FT

II. B. ABILITY OF WILLIAMS BRIDGE SPILLWAY TO PASS WILLIAMS BRIDGE COMPONENT OF ONE-HALF OF LAKE SCRANTON PMF

1. CAPACITY OF WILLIAMS BRIDGE SPILLWAY = 5,560 CFS
3. ONE-HALF OF THE WILLIAMS BRIDGE COMPONENT OF THE LAKE SCRANTON PMF PEAK FLOW IS GREATER THAN THE SPILLWAY CAPACITY (8,195 > 5,560)

b. ROUTING IS NOT AVAILABLE

(1.) THE SPILLWAY WILL PASS (5,560 / 8,195) = 0.678 = p = 67.8 % OF THE PEAK

(2.) INCLUSIVE 3 METHOD TO ESTIMATE

(a) TRIANGLE SHAPE FOR $\frac{1}{2}$ PMF HYDROGRAPH

(b) BASE TIME COMPUTATION – SAY TOTAL TIME (T) = WILLIAMS BRIDGE TIME

T FOR WILLIAMS BRIDGE, D.A. = 5.? SQ MI., = 24.5 HOURS.

$1 - p = 1.0 - 0.678 = 0.322 = \frac{\Delta AOC}{\Delta AOB}$

$\Delta AOB = \frac{1}{2} bh = \frac{1}{2}(24.5)(8,195) = 100,390$ CFS-HRS

$\Delta AOC = (1-p)\,\Delta AOB = (0.322)\,100,390 = 32,325$ CFS-HRS

32,325 CFS-HRS × (3,600 AC-SECS / 43,560 FT²-HRS) = 2,672 AC-FT

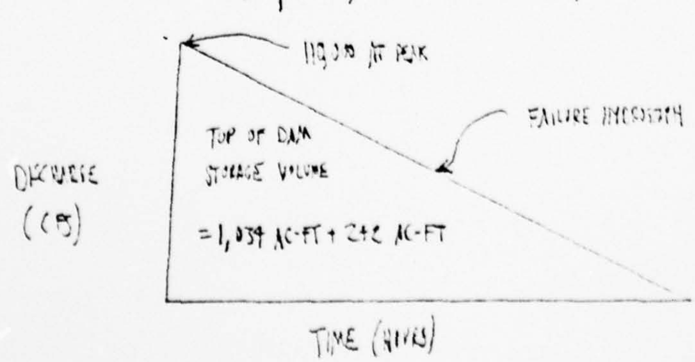
STORAGE REQUIRED = 2,672 AC-FT >> STORAGE AVAILABLE = 242 AC-FT

IT HAS BEEN SHOWN THAT THE WILLIAMS BRIDGE SPILLWAY CANNOT PASS THE WILLIAMS BRIDGE WATERSHED PMF (WILLIAMS BRIDGE PHASE I INSPECTION REPORT), $\frac{1}{2}$ OF THE WILLIAMS BRIDGE WATERSHED PMF (WILLIAMS BRIDGE PHASE I INSPECTION REPORT), THE WILLIAMS BRIDGE COMPONENT OF THE LAKE SCRANTON WATERSHED PMF, OR $\frac{1}{2}$ OF THE WILLIAMS BRIDGE COMPONENT OF THE LAKE SCRANTON WATERSHED PMF. ASSUME THAT UNDER ANY OF THE ABOVE SITUATIONS, WILLIAMS BRIDGE FAILS AND ESTIMATE THE CONSEQUENCES.

AN ATTEMPT HAS BEEN MADE BY BERTLE IN INSPECTION, MAINTENANCE, AND REHABILITATION OF OLD DAMS, ASCE, 1973, pp. 328 – 336 TO PRESENT AN ESTIMATE OF PEAK FLOW FROM A DAM FAILURE BASED ON THE HEIGHT OF DAM AND ACTUAL DAM FAILURE EXPERIENCE. ASSUME THAT A FAILURE OF WILLIAMS BRIDGE DAM WOULD FOLLOW THIS TREND, AND THAT THE TOTAL STORAGE VOLUME BEHIND THE DAM WOULD BE RELEASED.

WILLIAMS BRIDGE DAM HEIGHT = 54 FEET (WILLIAMS BRIDGE PHASE I INSPECTION REPORT)

FROM FIGURE 1, p. 329, PEAK FLOW = 110,000 CFS



GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT: LAKE SCRANTON DAM (35-21) FILE NO. 7613.1D
HYDROLOGY AND HYDRAULICS ANALYSIS SHEET NO. 8 OF 10 SHEETS
FOR: USCE - BALTIMORE DISTRICT
COMPUTED BY: JMC DATE: 5/6/73 CHECKED BY: DAW DATE: 5/6

INSPECTION, MAINTENANCE, AND REHABILITATION OF OLD DAMS, ASCE

SELECTING SPILLWAY FLOODS 329

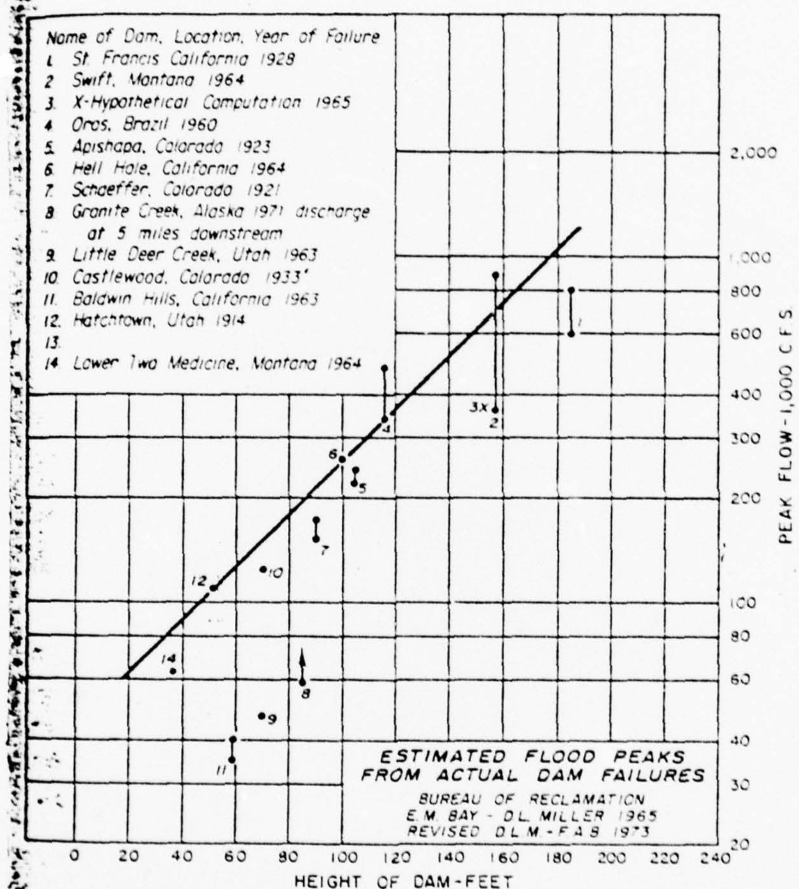


FIG. 1. -- ESTIMATED FLOOD PEAKS FROM ACTUAL DAM FAILURES

STORAGE VOLUME = 1,034 AC-FT + 242 AC-FT = 1,276 AC-FT

= 1,276 AC-FT × (43,560 FT²-HR / 3,600 AC-SEC)

= 15,440 CFS-HOURS

$A = \frac{1}{2} bh$; VOL = ½ × TIME × PEAK

15,440 CFS-HOURS = ½ T(HOURS) × 110,000 CFS

T(HOURS) = 0.281

T(MINUTES) = 17 MINUTES

I. B. ABILITY OF LAKE SCRANTON SPILLWAYS TO PASS RELEASE FROM WILLIAMS BRIDGE FAILURE

1. CAPACITY OF SPILLWAYS = 4,480 CFS
3. INFLOW IS GREATER THAN SPILLWAY CAPACITY (110,000 > 4,480)
   b. ROUTING IS NOT AVAILABLE
      (1.) THE SPILLWAY WILL PASS (4,480/110,000) = 0.041 = 4.1% = p OF THE PEAK
      (2.) INCLOSURE 3 METHOD TO ESTIMATE STORAGE EFFECT OF RESERVOIR
         (a) TRIANGULAR SHAPE FOR FAILURE HYDROGRAPH
         (b) FAILURE HYDROGRAPH VOLUME = 15,440 CFS-HOURS = 1,276 AC-FT = ΔAOB

$1-p = 1.0 - 0.041 = 0.959 = \frac{\Delta AOC}{\Delta AOB}$

$\Delta AOC = (1-p)\ \Delta AOB = (0.959)(1,276) = 1,224$ AC-FT = REQUIRED STORAGE

STORAGE REQUIRED = 1,224 AC-FT > STORAGE AVAILABLE = 755 AC-FT

SECOND CHECK - ASSUME WILLIAMS BRIDGE DRAINS COMPLETELY IN TWO HOURS

II. B. ABILITY OF LAKE SCRANTON SPILLWAYS TO PASS RELEASE FROM WILLIAMS BRIDGE FAILURE

1. CAPACITY OF SPILLWAYS = 4,480 CFS
3. INFLOW IS GREATER THAN SPILLWAY CAPACITY

VOLUME = ½ × TIME × PEAK

PEAK = 2×VOLUME / TIME = 2 × 15,440 CFS-HOURS / 2 HOURS

PEAK = 15,440 CFS > 4,480 CFS

   b. ROUTING IS NOT AVAILABLE
      (1.) THE SPILLWAY WILL PASS (4,480 / 15,440) = 0.290 = 29.0% = p OF THE PEAK
      (2.) INCLOSURE 3 METHOD TO ESTIMATE STORAGE EFFECT OF RESERVOIR
         (a) TRIANGULAR SHAPE FOR FAILURE HYDROGRAPH
         (b) FAILURE HYDROGRAPH VOLUME = 15,440 CFS-HOURS = 1,276 AC-FT = ΔAOB

$1-p = 1.0 - 0.290 = 0.710 = \frac{\Delta AOC}{\Delta AOB}$

$\Delta AOC = (1-p)\ \Delta AOB = (0.710)(1,276) = 906$ AC-FT = REQUIRED STORAGE

STORAGE REQUIRED = 906 AC-FT > STORAGE AVAILABLE = 755 AC-FT

∴ IF THE PMF OR ½ PMF OCCURS FOR WILLIAMS BRIDGE OR LAKE SCRANTON WATERSHEDS, LAKE SCRANTON WILL BE OVERTOPPED AND PROBABLY WILL FAIL.

C. PROCEDURES FOR DETERMINATION OF ADEQUATE / INADEQUATE SPILLWAY CAPACITY

2. STORAGE REQUIRED IS GREATER THAN STORAGE AVAILABLE

a. ETL 1110-2-

① THERE IS A HIGH HAZARD OF LOSS OF LIFE FROM LARGE FLOWS DOWNSTREAM OF DAM

② CHECK TAILWATER AT INSTANT BEFORE OVERTOPPING OCCURS

③ THE DAM AND SPILLWAYS ARE NOT CAPABLE OF PASSING ½ PMF WITHOUT OVERTOPPING FAILURE

c. TAILWATER AT INSTANT BEFORE OVERTOPPING OCCURS

SPILLWAY CAPACITY DISCHARGE = 4,480 CFS ; FROM HEC-2 COMPUTER RUN,

TAILWATER DEPTH @ Q = 4,480 CFS IS 8.3 FEET

TOP OF DAM ELEVATION	= 1286.1 FEET
HEIGHT OF DAM	= 60 FEET
BOTTOM OF DAM ELEVATION	= 1226.1 FEET
TAILWATER DEPTH	= 8.3 FEET
TAILWATER ELEVATION	= 1234.4 FEET
TOP OF DAM ELEV. − TAILWATER ELEV.	= 1286.1 − 1234.4 = 51.7′

PERCENT OF PMF THAT SPILLWAY CAN PASS
GENERAL FORMULA

$$\% \text{ OF PMF THAT SPILLWAY CAN PASS} = \frac{Q_T}{Q_{PMF}} \times 100\%,$$

WHERE $Q_T = Q_{SPILLWAY} + \frac{2S}{\Delta T}$,

$S = \sum_{i=1}^{n} S_i$ FOR UPSTREAM RESERVOIR CASES,

AND T = TOTAL TIME OF PMF HYDROGRAPH FROM CURVE FOR SUSQUEHANNA RIVER BASIN

$$\% \text{ OF PMF} = \frac{4,480 + \left(\frac{2 \times (755 + 242)\ \text{AC-FT}}{25.3\ \text{HOURS}} \times \frac{43,560\ \text{FT}^2\text{-HRS}}{3,600\ \text{AC-SECS}} \right)}{19,670} \times 100\%$$

$$= \frac{4,480 + 954}{19,670} \times 100\%$$

$$= 28\%$$

SUSQUEHANNA RIVER BASIN

STAFFORD MEADOW BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY

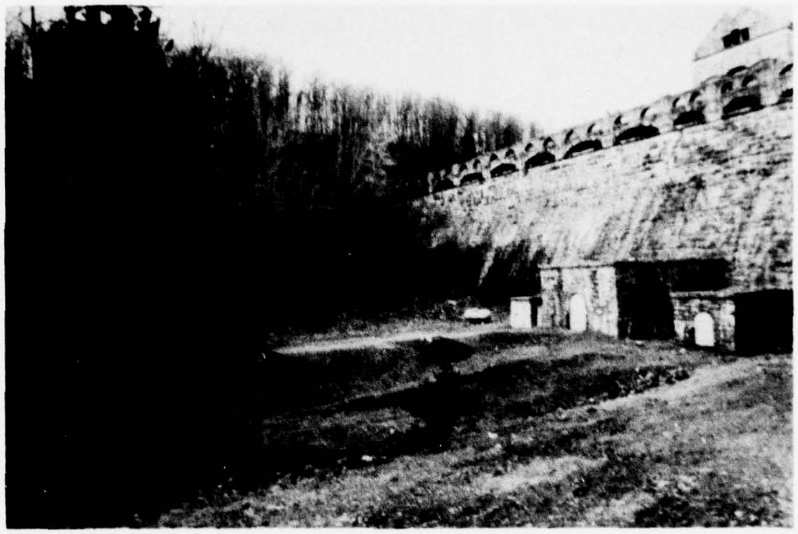
PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1978

APPENDIX D

PHOTOGRAPHS



A. Right Abutment and Right Side of Masonry Gravity Dam

B. Left Side of Masonry Gravity Dam and Embankment Retaining Wall

C. Right Bank Roadway Retaining Wall
Upstream of Masonry Gravity Dam

D. Embankment Retaining Wall Adjacent to
Masonry Gravity Dam

LAKE SCRANTON DAM

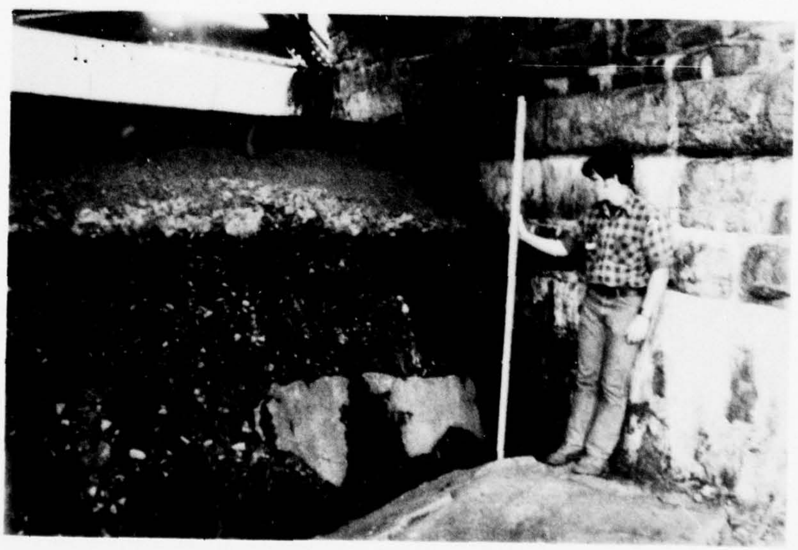
E. Wet Area in Vicinity of Drainage Collection Sump

F. 36- and 24-Inch Emergency Reservoir Drawdown Outlets Below Dam

G. Downstream Channel Below Masonry Gravity Dam

H. Bridge Over Main Spillway and Adjacent Embankment Dam

I. Main Spillway and Bridge over Crest
Looking Upstream



J. Damaged Area at Left End of
Main Spillway

K. Downstream Surface of Embankment to Left of Main Spillway

L. Downstream Channel Below Main Spillway

SUSQUEHANNA RIVER BASIN

STAFFORD MEADOW BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE SCRANTON DAM

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1978

APPENDIX E

GEOLOGY

AD-A068 852   GANNETT FLEMING CORDDRY AND CARPENTER INC HARRISBURG PA   F/G 13/2
NATIONAL DAM INSPECTION PROGRAM. LAKE SCRANTON DAM (NDS ID 374)--ETC(U)
MAY 78   DACW31-78-C-0046
UNCLASSIFIED   NL

2 OF 2
AD
A068852

END
DATE
FILMED
7-79
DDC

LAKE SCRANTON DAM

APPENDIX E

GEOLOGY

1. General Geology. The damsite and reservoir are located in the northeastern portion of Lackawanna County. Lackawanna County was completely covered with ice during the last continental glaciation of Pleistocene time. The general direction of ice movement was S 35°-40° W. Glacial drift covers the entire County, except where subsequent erosion has removed it. Thick deposits of glacial outwash occur in many places along the Lackawanna River, and are 50 to 100 feet thick near Dickson, Scranton, and Moosic.

The only important structural feature in Lackawanna County is the Lackawanna Syncline, which traverses the County in a southwesterly direction. The syncline enters the County at the northeast corner as a narrow shallow trough, gradually deepens and broadens toward the southwest, and reaches its maximum development in Luzerne County. The rock formations exposed range from the post-Pottsville formations (youngest) through the Pottsville, Mauch Chunk shale, Pocono sandstone to the Damascus formation of the Catskill group (oldest). The rim rocks, the Pottsville formation and Pocono sandstone, have dips that rarely exceed 10° to 20° and form a rather simple syncline. The core rocks, the post-Pottsville formations, are folded into a serious of minor anticlines and synclines which trend about N 70° E. The rocks in the northwestern and southeastern parts of the County, outside of the limits of the Lackawanna Syncline, are generally horizontally stratified.

The Lackawanna River, in general, follows the axis of the Lackawanna Syncline. Southeast of the Lackawanna River, the rise in terrain is quite gradual and the crests of the high mountains are several miles from the Lackawanna River. Streams, such as Roaring Brook and Stafford Meadow Brook, have cut deep canyons through the mountains and follow a tortuous course to their confluence with the Lackawanna River near Scranton, Pennsylvania. In the area of interest, the Lackawanna River streambed is founded in post-Pottsville formations. Proceeding uphill from the river, the older Pottsville formation, Mauch Chunk shale, Pocono sandstone, and Catskill continental group are encountered in turn. The tributary streams, in flowing down the mountains, have generally cut through or around the hard sandstone and conglomerate members, and have eroded their streambed into the softer shales and glacial till. The Catskill continental group of rocks underlies the greater part of Lackawanna County.

2. <u>Site Geology</u>. Except for the geologic formations involved, the foundation conditions for Lake Scranton afforded by Stafford Meadow Brook is characteristic of numerous other streams in this section of the State, such as at Williams Bridge and Elmhurst Dams. The dam is founded partially upon Mauch Chunk shale and partially upon Pottsville sandstone and conglomerate. The right high, or masonry portion of the dam, is founded upon and keyed into the gray Pottsville sandstone and conglomerate. The stratification of this massive rock has a slight dip into the right abutment. From about the middle of the original creekbed, and into the left abutment, the 1914 report of the Pennsylvania Water Supply Commission indicates that a hardpan was utilized as the foundation for the embankment portion of the dam. A black to deep blue clay was reported to have been present immediately above the hardpan. This could have been the decomposed remains of the coal and clay shale strata usually found near the base of the Pottsville formation and above the Mauch Chunk shale formations. The hardpan was probably decomposed Mauch Chunk shale or glacial till.